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VOLUME XLI.

CONTAINING

ISSUED FOR 1887.

JANUARY, 1888.

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AND

I. A CATALOGUE OF THE WORKS ALREADY PUBLISHED;

II. A CLASSIFIED LIST OF THE MONOGRAPHS COMPLETED, IN COURSE OF PUBLICATION, AND IN PREPARATION, WITH THE NAMES OF THEIR RESPECTIVE AUTHORS;

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V. A STRATIGRAPHICAL LIST OF THE BRITISH FOSSILS FIGURED AND DESCRIBED IN THE YEARLY VOLUMES.

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§ I. CATALOGUE OF WORKS

ALREADY PUBLISHED BY

THE PALÆONTOGRAPHICAL SOCIETY:

Showing the ORDER *of publication; the* YEARS *during which the Society has been in operation; and the* CONTENTS *of each yearly Volume.*

Vol. I. Issued for the Year	1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood, 21 plates.
„ II. „	1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell, 38 plates. The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards, 9 plates.
„ III.* „	1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones, 7 plates. The Permian Fossils, by Prof. Wm. King, 29 plates. The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen, 18 plates. The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime, 11 plates.
„ IV. „	1850	The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood, 12 plates. The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett, 15 plates. The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson, 13 plates.
„ V. „	1851	The Reptilia of the Cretaceous Formations, by Prof. Owen, 39 plates. The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime, 19 plates. The Fossil Lepadidæ, by Mr. Charles Darwin, 5 plates.
„ VI. „	1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson, 2 plates. The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson, 5 plates. The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson, 5 plates. The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards, 6 plates. The Radiaria of the Crag, London Clay, &c., by Prof. E. Forbes, 4 plates.
„ VII. „	1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime, 10 plates. The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson, 9 plates. The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe, 10 plates. The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett, 8 plates. The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood, 8 plates. The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen, 9 plates.

* The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils;' the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF WORKS—Continued.

Vol. VIII.	Issued for the Year *1854	The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous, with Appendix and Index to Vol. I, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen, 20 plates. The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett, 7 plates. The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin, 2 plates. The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe, 6 plates. The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards, 8 plates.
„ IX.	„ †1855	The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood, 11 plates. The Reptilia of the Wealden Formations, Part III, by Prof. Owen, 12 plates. The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards, 4 plates. The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe, 11 plates. The Tertiary Entomostraca, by Mr. T. R. Jones, 6 plates. The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright, 10 plates.
„ X.	„ 1856	The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright, 12 plates. The Fossil Crustacea, Part I, London Clay, by Prof. Bell, 11 plates. The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson, 4 plates. The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part IV (Supplement No. 1), by Prof. Owen, 11 plates. The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen, 2 plates.
„ XI.	„ 1857	The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright, 14 plates. The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen, 4 plates. The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen, 8 plates. The Polyzoa of the Crag, by Prof. Busk, 22 plates.
„ XII.	„ 1858	The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright, 7 plates. The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards, 6 plates. The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen, 7 plates. The Reptilia of the Purbeck Limestones, by Prof. Owen, 1 plate. The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous, by Mr. Davidson, 10 plates.
„ XIII.	„ 1859	The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson, 20 plates. The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen, 6 plates. The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen, 1 plate. The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood, 13 plates.
„ XIV.	„ 1860	The Fossil Brachiopoda, Vol. II, Part V, No. 5, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen, 11 plates. The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen, 1 plate. The Fossil Estheriæ, by Prof. Rupert Jones, 5 plates. The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell, 11 plates.
„ XV.	„ 1861	The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright, 13 plates. Supplement to the Great Oolite Mollusca, by Dr. Lycett, 15 plates.
„ XVI.	„ 1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright, 11 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter, 6 plates. The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson, 9 plates. The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood, 7 plates. The Reptilia of the Cretaceous and Wealden Formations (Supplements), by Prof. Owen, 10 plates.
„ XVII.	„ 1863	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter, 8 plates. The Fossil Brachiopoda, Vol. III, Part VI, No. 2, Devonian, by Mr. Davidson, 11 plates. The Belemnitidæ, Part I, Introduction, by Prof. Phillips. The Reptilia of the Liassic Formations, Part I, by Prof. Owen, 16 plates.

* This Vol. is marked on the outside 1855.
† This Vol. is marked on the outside 1856.

CATALOGUE OF WORKS—Continued.

Vol. XVIII.	Issued for the Year 1864	The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright, 6 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter, 11 plates. The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips, 7 plates. The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford, 5 plates. Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.
„ XIX.*	„ 1865	The Crag Foraminifera, Part I, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, 4 plates. Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan, 10 plates. The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward, 9 plates. The Fossil Brachiopoda, Vol. III, Part VII, No. 1, Silurian, by Mr. Davidson, 12 plates.
„ XX.*	„ 1866	Supplement to the Fossil Corals, Part IV, No. 1, Liassic, by Dr. Duncan, 11 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part IV (Silurian), by Mr. J. W. Salter, 6 plates. The Fossil Brachiopoda, Vol. III, Part VII, No. 2, Silurian, by Mr. Davidson, 10 plates. The Belemnitidæ, Part III, Liassic Belemnites, by Prof. Phillips, 13 plates.
„ XXI.*	„ 1867	Flora of the Carboniferous Strata, Part I, by Mr. E. W. Binney, 6 plates. Supplement to the Fossil Corals, Part IV, No. 2, Liassic, by Dr. Duncan, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part II, by Dr. Wright, 14 plates. The Fishes of the Old Red Sandstone, Part I, by Messrs. J. Powrie and E. Ray Lankester, 5 plates. The Pleistocene Mammalia, Part II, Felis spelæa, continued, by Messrs. W. Boyd Dawkins and W. A. Sanford, 14 plates.
„ XXII.*	„ 1868	Supplement to the Fossil Corals, Part II, No. 1, Cretaceous, by Dr. Duncan, 9 plates. The Fossil Merostomata, Part II, Pterygotus, by Mr. H. Woodward, 6 plates. The Fossil Brachiopoda, Vol. III, Part VII, No. 3, Silurian, by Mr. Davidson, 15 plates. The Belemnitidæ, Part IV, Liassic and Oolitic Belemnites, by Prof. Phillips, 7 plates. The Reptilia of the Kimmeridge Clay, No. 3, by Prof. Owen, 4 plates. The Pleistocene Mammalia, Part III, Felis spelæa, concluded, with F. lynx, by Messrs. W. Boyd Dawkins and W. A. Sanford, 6 plates.
„ XXIII.*	„ 1869	Supplement to the Fossil Corals, Part II, No. 2, Cretaceous, by Dr. Duncan, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part III, by Dr. Wright, 10 plates. The Belemnitidæ, Part V, Oxford Clay, &c., Belemnites, by Prof. Phillips, 9 plates. The Fishes of the Old Red Sandstone, Part I (concluded), by Messrs. J. Powrie and E. Ray Lankester, 9 plates. The Reptilia of the Liassic Formations, Part II, by Prof. Owen, 4 plates. The Crag Cetacea, No. 1, by Prof. Owen, 5 plates.
„ XXIV.*	„ 1870	The Flora of the Carboniferous Strata, Part II, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part IV, by Dr. Wright, 10 plates. The Fossil Brachiopoda, Vol. III, Part VII, No. 4, Silurian, by Mr. Davidson, 13 plates. The Eocene Mollusca, Part IV, No. 3, Bivalves, by Mr. S. V. Wood, 5 plates. The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen, 4 plates.
„ XXV.*	„ 1871	The Flora of the Carboniferous Strata, Part III, by Mr. E. W. Binney, 6 plates. The Fossil Merostomata, Part III, Pterygotus and Slimonia, by Mr. H. Woodward, 5 plates. Supplement to the Crag Mollusca, Part I (Univalves), by Mr. S. V. Wood, with an Introduction on the Crag District, by Messrs. S. V. Wood, jun., and F. W. Harmer, 7 plates and map. Supplement to the Reptilia of the Wealden (Iguanodon), No. IV, by Prof. Owen, 3 plates The Pleistocene Mammalia, Part IV, Felis pardus, &c., by Messrs W. Boyd Dawkins and W. A. Sanford, 2 plates. The Pleistocene Mammalia, Part V, Ovibos moschatus, by Mr. W. Boyd Dawkins, 5 plates.

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

CATALOGUE OF WORKS—Continued.

Vol. XXVI*	Issued for the Year 1872	Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan, with an Index to the Tertiary and Secondary Species, 7 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright, 5 plates. The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward, 10 plates. The Fossil Trigoniæ, No. I, by Dr. Lycett, 9 plates.
„ XXVII.*	„ 1873	The Fossil Echinodermata, Cretaceous, Vol I, Part VI, by Dr. Wright, 8 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part I (Tertiary and Cretaceous), by Mr. Davidson, 8 plates. Supplement to the Crag Mollusca, Part II (Bivalves), by Mr. S. V. Wood, 5 plates. Supplement to the Reptilia of the Wealden (Iguanodon), No. V, by Prof. Owen, 2 plates. Supplement to the Reptilia of the Wealden (Hylæochampsa) No. VI, by Prof. Owen. The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen, 2 plates.
„ XXVIII*	„ 1874	The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, 16 plates. The Carboniferous Entomostraca, Part I (Cypridinadæ), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady, 5 plates. The Fossil Trigoniæ, No. II, by Dr. Lycett, 10 plates.
„ XXIX*	„ 1875	The Flora of the Carboniferous Strata, Part IV, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part VII, by Dr. Wright, 10 plates. The Fossil Trigoniæ, No. III, by Dr. Lycett, 8 plates. The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen, 20 plates.
„ XXX.*	„ 1876	The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady, 12 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 1 (Jurassic and Triassic), by Mr. Davidson, 8 plates. Supplement to the Reptilia of the Wealden (Poikilopleuron and Chondrosteosaurus), No. VII, by Prof. Owen, 6 plates.
„ XXXI.*	„ 1877	Supplement to the Eocene Mollusca (Bivalves), by Mr. S. V. Wood, 2 plates. The Fossil Trigoniæ, No. IV, by Dr. Lycett, 13 plates. The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood, 1 plate. The Carboniferous Ganoid Fishes, Part I (Palæoniscidæ), by Dr. Traquair, 7 plates. The Fossil Reptilia of the Mesozoic Formations, Part III, by Prof. Owen, 2 plates. The Fossil Elephants (E. antiquus), Part I, by Prof. Leith Adams, 5 plates.
„ XXXII.*	„ 1878	The Fossil Echinodermata, Cretaceous, Vol. I, Part VIII, by Dr. Wright, 8 plates. Index and Title Page to the Fossil Echinodermata, Oolitic, Vol. I (Echinoidea), by Dr. Wright. The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward, 6 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson, 13 plates. The Lias Ammonites, Part I, by Dr. Wright, 8 plates. The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall, 6 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen, 6 plates. The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins.
„ XXXIII*	„ 1879	The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen, 5 plates. Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood, 6 plates. The Fossil Trigoniæ, No. V (*Conclusion*), by Dr. Lycett, 1 plate. The Lias Ammonites, Part II, by Dr. Wright, 10 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen, 4 plates. The Fossil Elephants (E. primigenius), Part II, by Prof. Leith Adams, 10 plates.

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CATALOGUE OF WORKS—Continued.

Vol. XXXIV*	Issued for the Year 1880	The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen, 6 plates. The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright, 3 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part III (Permian and Carboniferous), by Mr. Davidson, 8 plates. The Lias Ammonites, Part III, by Dr. Wright, 22 plates. The Reptilia of the London Clay, Vol. II, Part I (Chelone) by Prof. Owen, 2 plates.
„ XXXV*	„ 1881	The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright, 6 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson, 5 plates. The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett. The Lias Ammonites, Part IV, by Dr. Wright, 10 plates. The Reptilia of the Liassic Formations, Part III (*Conclusion*), by Prof. Owen, 13 plates. The Fossil Elephants (E. primigenius and E. meridionalis), Part III (*Conclusion*), by Prof. Leith Adams, 13 plates.
„ XXXVI*	„ 1882	The Eocene Flora, Vol. I, Part III (*Conclusion*), by Mr. J. S. Gardner and Baron Ettingshausen, 2 plates. Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood, 1 plate. The Fossil Echinodermata, Cretaceous, Vol. I, Part X (*Conclusion*), by Dr. Wright, 5 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part V (*Conclusion*), by Dr. Davidson. Supplement to the Fossil Brachiopoda, Vol. V, Part I (Devonian and Silurian), by Dr. Davidson, 7 plates. The Lias Ammonites, Part V, by Dr. Wright, 22 plates.
„ XXXVII*	„ 1883	The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner, 9 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part V (*Conclusion*), by the late Mr. J. W. Salter. The Carboniferous Trilobites, Part I, by Dr. H. Woodward, 6 plates. Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson, 10 plates. The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett, 4 plates. The Lias Ammonites, Part VI, by Dr. Wright, 8 plates.
„ XXXVIII*	„ 1884	The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner, 11 plates. The Carboniferous Entomostraca, Part I, No. 2 (*Conclusion*), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady, 2 plates. The Carboniferous Trilobites, Part II, by Dr. H. Woodward, 4 plates. Supplement to the Fossil Brachiopoda, Vol. V, Part III (*Conclusion*), by Dr. Davidson, 4 plates. The Lias Ammonites, Part VII, by Dr. Wright, 10 plates.
„ XXXIX*	„ 1885	The Eocene Flora, Vol. II, Part III (*Conclusion*), by Mr. J. S. Gardner, 7 plates. The Stromatoporoids, Part I, by Prof. Alleyne Nicholson, 11 plates. The Fossil Brachiopoda (Bibliography), Vol. VI (*Conclusion*), by the late Dr. Davidson and Mr. W. H. Dalton. The Lias Ammonites, Part VIII (*Conclusion*), by the late Dr. Wright, 1 plate.
„ XL*	„ 1886	The Morphology and Histology of Stigmaria Ficoides, by Prof. W. C. Williamson, 15 plates. The Fossil Sponges, Part I, by Dr. G. J. Hinde, 8 plates. The Jurassic Gasteropoda, Part I, No. 1, by Mr. W. H. Hudleston. The Inferior Oolite Ammonites, Part I, by Mr. S. S. Buckman, 6 plates. The Pleistocene Mammalia, Part VI, by Prof. Boyd Dawkins, 7 plates.
„ XLI*	„ 1887	The Fossil Sponges, Part II, by Dr. G. J. Hinde, 1 plate. The Palæozoic Phyllopoda, Part I, by Prof. T. R. Jones and Dr. Woodward, 12 plates. The Jurassic Gasteropoda, Part I, No. 2, by Mr. W. H. Hudleston, 6 plates. Inferior Oolite Ammonites, Part II, by Mr. S. S. Buckman, 8 plates.

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§ II. LIST OF MONOGRAPHS

Completed, in course of Publication, and in Preparation.

1. MONOGRAPHS which have been COMPLETED, and which may be bound as separate Volumes:—

The Morphology and Histology of Stigmaria ficoides by Prof. W. C. Williamson. (*Complete with Title-page and Index in the Volume for* 1886.)

The Eocene Flora, Vol. I (Filices), by Mr. J. S. Gardner and Baron Ettingshausen. (*Complete in the Volumes for the years* 1879, 1880, *and* 1882. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1882.)

The Eocene Flora, Vol. II (Gymnospermæ), by Mr. J. S. Gardner. (*Complete in the Volumes for* 1883, 1884, *and* 1885. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1885.)

The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady. (*Complete in the Volume for the year* 1876.)

The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime. (*Complete in the Volumes for the years* 1849, 1851, 1852, 1853, *and* 1854. *The Title-page and Index, with corrected explanations of Plates XVII and XVIII, will be found in the Volume for the year* 1854.)

The Polyzoa of the Crag, by Mr. G. Busk. (*Complete with Title-page and Index in the Volume for the year* 1857.)

The Tertiary Echinodermata, by Professor Forbes. (*Complete with Title-page in the Volume for the year* 1852.)

The Fossil Cirripedes, by Mr. C. Darwin. (*Complete in the Volumes for the years* 1851, 1854, *and* 1858. *The Title-page will be found in the Volume for the year* 1854, *and the Index in the Volume for the year* 1858.

The Post-Tertiary Entomostraca, by Mr. G. S. Brady, the Rev. H. W. Crosskey, and Mr. D. Robertson. (*Complete, with Title-page and Index, in the Volume for the year* 1874.)

The Tertiary Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1855.)

The Cretaceous Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1849.)

The Carboniferous Entomostraca, Part I (Cypridinadæ and their allies), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady. (*Complete in the volumes for* 1874 *and* 1884. *The Title-page and Index will be found in the Volume for the year* 1884.)

The Fossil Estheriæ, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1860.)

The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter. (*Complete in the Volumes for the years* 1862, 1863, 1864, 1866, *and* 1883. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Fossil Merostomata, by Dr. H. Woodward. (*Complete in the Volumes for the years* 1865, 1868, 1871, 1872, *and* 1878. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1878.)

The Fossil Brachiopoda (Tertiary, Cretaceous, Oolitic, and Liassic), Vol. I, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1850, 1852, 1853, *and* 1854. *The Index will be found in the Volume for the year* 1854, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Permian and Carboniferous), Vol. II, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1856, 1857, 1858, 1859, *and* 1860. *The Index will be found in the Volume for the year* 1860, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Devonian and Silurian), Vol. III, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1862, 1863, 1865, 1866, 1868, *and* 1870. *The Title-page and Index will be found in the Volume for the year* 1870.)

The Fossil Brachiopoda, Vol. IV, by Dr. T. Davidson. Supplements: Tertiary, Cretaceous, Jurassic, Triassic, Permian, and Carboniferous. (*Complete in the Volumes for the years* 1873, 1876, 1878, 1880, 1881, *and* 1882. *The Title-page and Index, with directions for the binding will be found in the Volume for the year* 1882.)

The Fossil Brachiopoda, Vol. V, by Dr. T. Davidson. Supplements: Devonian and Silurian. Appendix to Supplements, General Summary, Catalogue and Index of the British Species. (*Complete in the Volumes for the years* 1882, 1883, *and* 1884. *The Title-page, with directions for the binding will be found in the Volume for* 1884.)

The Fossil Brachiopoda, Vol. VI, by Dr. T. Davidson and Mr. W. H. Dalton. Bibliography. (*Complete in the Volume for the year* 1885.)

The Eocene Bivalves, Vol. I, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volumes for the years* 1859, 1862, *and* 1870. *The directions for the binding will be found in the Volume for the year* 1870.)

Supplement to the Eocene Bivalves, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1877.)

The Eocene Cephalopoda and Univalves, Vol. I, by Mr. F. E. Edwards and Mr. S. V. Wood. (*Complete in the Volumes for the years* 1848, 1852, 1854, 1855, 1858, *and* 1877. *The Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1877.)

The Mollusca of the Crag, Vol. I, Univalves, by Mr. S. V. Wood. (*The Text, Plates, and Index, will be found in the Volume for the year* 1847, *and the Title-page will be found in the Volume for the year* 1855.)

The Mollusca of the Crag, Vol. II, Bivalves, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1850, 1853, 1855, 1858, *and* 1873. *The Title-page will be found in the Volume for the year* 1873, *and the Index will be found in the Volume for the year* 1855, *and a Note in the Volume for the year* 1858).

The Mollusca of the Crag, Vol. III, Supplement, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1871 *and* 1873. *The Title-page and Index will be found in the Volume for the year* 1873.)

Second Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1879.)

Third Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1882.)

The Great Oolite Mollusca, by Professor Morris and Dr. Lycett. (*Complete in the Volumes for the years* 1850, 1853, *and* 1854. *The Title-page and Index will be found in the Volume for the year* 1854.)

The Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1872, 1874, 1875, 1877, *and* 1879. *The directions for the binding will be found in the Volume for the year* 1879.)

Supplement to the Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1881 *and* 1883. *The Title-page, Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Oolitic Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1855, 1856, 1857, 1858, *and* 1878. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1878.)

The Oolitic Echinodermata, Vol. II, Asteroidea, by Dr. Wright. (*Complete in the Volumes for the years* 1861, 1864, *and* 1880. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1880).

The Cretaceous Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, *and* 1882. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1882.)

The Cretaceous (Upper) Cephalopoda, by Mr. D. Sharpe. (*Complete in the Volumes for the years* 1853, 1854, *and* 1855, *but wants Title-page and Index.*)

The Lias Ammonites, by Dr. Wright. (*Complete in the Volumes for the years* 1878, 1879, 1880, 1881, 1882, 1883, 1884, *and* 1885. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1885.)

The Fossils of the Permian Formation, by Professor King. *Complete, with Title-page and Index, in the Volume for the year* 1849. *Corrected explanations of Plates XXVIII and XXVIII* will be found in the Volume for the year* 1854.)

The Reptilia of the London Clay (and of the Bracklesham and other Tertiary Beds), Vol. I, by Professors Owen and Bell. (*Complete in the Volumes for the years* 1848, 1849, 1856, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Cretaceous Formations, by Prof. Owen. (*Complete in the Volumes for the years* 1851, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations, by Professor Owen. (*Complete in the Volumes for the years* 1853, 1854, 1855, 1856, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Liassic Formations, by Professor Owen. (*Complete in the Volumes for the years* 1859, 1860, 1863, 1869, *and* 1881. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1881.)

The Fossil Mammalia of the Mesozoic Formations, by Professor Owen. (*Complete, with Title-page and Table of Contents, in the Volume for the year* 1870.)

The Fossil Elephants, by Professor Leith Adams. (*Complete in the Volumes for the years* 1877, 1879, *and* 1881. *Directions for the binding, Title-page, and Index will be found in the Volume for the year* 1881.

2. MONOGRAPHS in course of PUBLICATION :—†

The Eocene Flora, by Mr. J. S. Gardner.
The Fossil Sponges, by Dr. G. J. Hinde.
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.
The Stromatoporoids, by Prof. H. Alleyne Nicholson.
Supplement to the Fossil Corals, by Dr. Duncan.
The Jurassic Gasteropoda, by Mr. W. H. Hudleston.
The Palæozoic Phyllopoda, by Prof. T. Rupert Jones and Dr. H. Woodward.
The Trilobites, by Dr. H. Woodward.
The Inferior Oolite Ammonites, by Mr. S. S. Buckman.
The Belemnites, by Professor Phillips.*
The Sirenoid and Crossopterygian Ganoids, by Professor Miall.
The Fishes of the Carboniferous Formation, by Prof. Traquair.
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, and Professor Traquair.
The Reptilia of the Wealden Formation (Supplements), by Professor Owen.
The Reptilia of the Kimmeridge Clay, by Professor Owen.
The Reptilia of the Mesozoic Formations, by Professor Owen.
The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.
The Cetacea of the Crag, by Professor Owen.

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3. MONOGRAPHS which are in course of PREPARATION :—†

The Fossil Cycadeæ, by Mr. W. Carruthers.
The Rhizopoda of the Chalk, Chalk Marl, Gault, and Upper Greensand, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.
The Foraminifera of the Lias, by Mr. H. B. Brady.
The Carboniferous Entomostraca, Part II (Leperditiadæ), by Messrs. T. Rupert Jones, J. W. Kirkby, and G. S. Brady.
Supplement to the Tertiary and Cretaceous Entomostraca, by Prof. T. Rupert Jones.
The Wealden, Purbeck, and Jurassic Entomostraca, by Messrs. T. R. Jones and G. S. Brady.
The Cretaceous Mollusca (exclusive of the Brachiopoda), by the Rev. Prof. T. Wiltshire.
The Purbeck Mollusca, by Mr. R. Etheridge.
The Rhætic Mollusca, by Mr. R. Etheridge.
The Silurian Fish Bed, by Dr. Harley.

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* Unfinished through the death of the Author, but will be continued by Mr. R. Etheridge.

† Members having specimens which might assist the authors in preparing their respective Monographs are requested to communicate in the first instance with the Honorary Secretary.

§ III. Dates of the Issue of the Yearly Volumes of the Palæontographical Society.

Volume	I	for	1847	was	issued	to the	Members,	March, 1848.
,,	II	,,	1848	,,		,,	,,	July, 1849.
,,	III	,,	1849	,,		,,	,,	August, 1850.
,,	IV	,,	1850	,,		,,	,,	June, 1851.
,,	V	,,	1851	,,		,,	,,	June, 1851.
,,	VI	,,	1852	,,		,,	,,	August, 1852.
,,	VII	,,	1853	,,		,,	,,	December, 1853.
,,	VIII	,,	1854	,,		,,	,,	May, 1855.
,,	IX	,,	1855	,,		,,	,,	February, 1857.
,,	X	,,	1856	,,		,,	,,	April, 1858.
,,	XI	,,	1857	,,		,,	,,	November, 1859
,,	XII	,,	1858	,,		,,	,,	March, 1861.
,,	XIII	,,	1859	,,		,,	,,	December, 1861.
,,	XIV	,,	1860	,,		,,	,,	May, 1863.
,,	XV	,,	1861	,,		,,	,,	May, 1863.
,,	XVI	,,	1862	,,		,,	,,	August, 1864.
,,	XVII	,,	1863	,,		,,	,,	June, 1865.
,,	XVIII	,,	1864	,,		,,	,,	April, 1866.
,,	XIX	,,	1865	,,		,,	,,	December, 1866.
,,	XX	,,	1866	,,		,,	,,	June, 1867.
,,	XXI	,,	1867	,,		,,	,,	June, 1868.
,,	XXII	,,	1868	,,		,,	,,	February, 1869.
,,	XXIII	,,	1869	,,		,,	,,	January, 1870.
,,	XXIV	,,	1870	,,		,,	,,	January, 1871.
,,	XXV	,,	1871	,,		,,	,,	June, 1872.
,,	XXVI	,,	1872	,,		,,	,,	October, 1872.
,,	XXVII	,,	1873	,,		,,	,,	February, 1874.
,,	XXVIII	,,	1874	,,		,,	,,	July, 1874.
,,	XXIX	,,	1875	,,		,,	,,	December, 1875.
,,	XXX	,,	1876	,,		,,	,,	December, 1876.
,,	XXXI	,,	1877	,,		,,	,,	February, 1877.
,,	XXXII	,,	1878	,,		,,	,,	March, 1878.
,,	XXXIII	,,	1879	,,		,,	,,	May, 1879.
,,	XXXIV	,,	1880	,,		,,	,,	May, 1880.
,,	XXXV	,,	1881	,,		,,	,,	May, 1881.
,,	XXXVI	,,	1882	,,		,,	,,	June, 1882.
,,	XXXVII	,,	1883	,,		,,	,,	October, 1883.
,,	XXXVIII	,,	1884	,,		,,	,,	December, 1884.
,,	XXXIX	,,	1885	,,		,,	,,	January, 1886.
,,	XL	,,	1886	,,		,,	,,	March, 1887.
,,	XLI	,,	1887	,,		,,	,,	January, 1888.

§ IV. SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JANUARY, 1888): *showing in the* FIRST *column whether each Monograph hitherto published be* complete, *or in the* course of completion; *in the* SECOND *column, the yearly volumes which contain each particular Monograph (as a guide to binding the same); and in the* FOURTH *and following columns, the number of pages, plates, figures, and species described in the different Monographs.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
The Morphology and Histology of Stigmaria ficoides, by Prof. W. C. Williamson, COMPLETE	1886	1887	66	15	91	1
The Eocene Flora, by Mr. J. S. Gardner and Baron Ettingshausen. Vol. I, COMPLETE	1879, 1880, 1882	1879, 1880, 1882	87	13	151	23
„ „ by Mr. J. S. Gardner. Vol. II, COMPLETE	1883, 1884, 1885	1883, 1884, 1886	159	27	400	31
The Flora of the Carboniferous Strata, by Mr. E. W. Binney, *in course of completion*	1867, 1870, 1871, 1875	1868, 1871, 1872, 1875	147	24	141	16
The Fossil Sponges, by Dr. G. J. Hinde, *in course of completion*	1886, 1887	1887, 1888	188	9	337	50
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, *in course of completion*	1865	1866	78	4	211	43
The Carboniferous and Permian Foraminifera, by Mr. H. B. Brady, COMPLETE	1876	1876	166	12	266	62
The Stromatoporoids, by Prof. Alleyne Nicholson, *in course of completion*	1885	1886	133	11	187	—
Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime, COMPLETE (*k*)	1849, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1855	406	72	800	319*g*
Supplement to the Fossil Corals, by Prof. Duncan, *in course of completion*	1865, 1866, 1867, 1868, 1869, 1872	1866, 1867, 1868, 1869, 1870, 1872	232	49	797	149
The Polyzoa of the Crag, by Mr. G. Busk, COMPLETE	1857	1859	145	22	641	122
The Tertiary Echinodermata, by Prof. Forbes, COMPLETE	1852	1852	39	4	144	44
The Oolitic Echinodermata, by Dr. Wright. Vol. I, COMPLETE (*l*)	1855, 1856, 1857, 1858, 1878	1857, 1858, 1859, 1861, 1878	491	43	724	120*h*
„ „ Vol. II, COMPLETE	1861, 1864, 1880	1863, 1866, 1880	207	22	232	35
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, COMPLETE	1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882	1864, 1868, 1870, 1871, 1872, 1874, 1875, 1878, 1881, 1882	390	87	1119	113
The Fossil Cirripedes, by Mr. C. Darwin, COMPLETE	1851, 1854, 1858*a*	1851, 1855, 1861	137	7	320	54
The Fossil Merostomata, by Dr. H. Woodward, COMPLETE	1865, 1868, 1871, 1872, 1878	1866, 1869, 1872, 1872, 1878	265	36	365	51
The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, COMPLETE	1874	1874	237	16	515	134
The Tertiary Entomostraca, by Prof. Rupert Jones, COMPLETE	1855	1857	74	6	233	56
The Cretaceous Entomostraca, by Prof. Rupert Jones, COMPLETE	1849	1850	41	7	176	27
The Carboniferous Entomostraca, by Prof. Rupert Jones and Messrs. J. W. Kirkby and Prof. G. S. Brady. Part I, COMPLETE	1874, 1884	1874, 1884	95	7	374	81
The Fossil Estheriæ, by Prof. Rupert Jones, COMPLETE	1860	1863	139	5	158	19*i*
The Palæozoic Phyllopoda, by Prof. Rupert Jones and Dr. H. Woodward, *in course of completion*	1887	1888	72	12	121	39
		CARRIED FORWARD...	3994	510	8503	1589

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JANUARY, 1888)—*continued.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m.* Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		BROUGHT FORWARD...	3994	510	8503	1589
The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter, COMPLETE	1862, 1863, 1864, 1866, 1883	1864, 1865, 1866, 1867, 1883	224	31	703	114
The Carboniferous Trilobites, by Dr. H. Woodward, COMPLETE	1883, 1884	1883, 1884	86	10	148	31
The Malacostracous Crustacea (comprising those of the London Clay, Gault, and Greensands), by Prof. T. Bell, *in course of completion*	1856, 1860	1858, 1863	88	22	215	50
The Fossil Brachiopoda, Vol. I. The Tertiary, Cretaceous, Oolitic, and Liassic Brachiopoda, by Mr. T. Davidson, COMPLETE	1850, 1852, 1853, 1854	1851, 1852, 1853, 1855	409	42	1855	160
,, ,, Vol. II. The Permian and Carboniferous Brachiopoda, COMPLETE	1856*d*, 1857, 1858, 1859, 1860	1858, 1859, 1861, 1861, 1863	331	59	1909	157
,, ,, Vol. III. The Devonian and Silurian Brachiopoda, COMPLETE	1862, 1863, 1865, 1866, 1868, 1870	1864, 1865, 1866, 1867, 1869, 1871	528	70	2766	321
,, ,, Vol. IV. Supplements, Tertiary to Carboniferous, COMPLETE	1873, 1876, 1878, 1880, 1881, 1882	1874, 1876, 1878, 1880, 1881, 1882	383	42	1664	215
,, ,, Vol. V. Supplements, Devonian and Silurian, COMPLETE	1882, 1883, 1884	1882, 1883, 1884	476	21	1135	116
,, ,, Vol. VI. Bibliography, COMPLETE	1885	1886	163	—	—	—
The Fossil Trigoniæ, by Dr. Lycett, COMPLETE	1872, 1874, 1875, 1877, 1879	1872, 1874, 1875, 1877, 1879	246	41	446	115
Supplement to the Fossil Trigoniæ, by Dr. Lycett, COMPLETE	1881, 1883	1881, 1883	19	4	53	9*h*
The Mollusca of the Crag, by Mr. S. V. Wood:—						
Vol. I. (Univalves), COMPLETE	1847, 1855*b*	1848, 1857	216	21	581	244
Vol. II. (Bivalves), COMPLETE	1850, 1853, 1855, 1858*c*	1851, 1853, 1857, 1861	344	31	691	253
Supplements to the Crag Mollusca, No. I and II, by Mr. S. V. Wood, COMPLETE	1871, 1873, 1879	1872, 1874, 1879	322	18	517	232
,, ,, No. III ,, COMPLETE	1882	1882	24	1	29	13
The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, continued by Mr. S. V. Wood. Vol. I, COMPLETE	1848, 1852, 1854, 1855, 1858, 1877	1849, 1852, 1855, 1857, 1861, 1877	361	34	625	275
The Eocene Mollusca, Bivalves, by Mr. S. V. Wood. Vol. I, COMPLETE	1859, 1862, 1870	1861, 1864, 1871	182	25	531	194
Supplement to the Eocene Mollusca, by Mr. S. V. Wood (Bivalves). Vol. I, COMPLETE	1877	1877	24	2	66	30
The Great Oolite Mollusca, by Prof. Morris and Dr. Lycett, COMPLETE	1850, 1853, 1854	1850, 1853, 1855	282	30	846	419
,, ,, ,, Supplement by Dr. Lycett, COMPLETE	1861	1863	129	15	337	194
The Jurassic Gasteropoda, by Mr. W. H. Hudleston, *in course of completion*	1886, 1887	1887, 1888	136	6	207	45
The Inferior Oolite Ammonites, by Mr. S. S. Buckman, *in course of completion*	1886, 1887	1887, 1888	56	14	104	12
The Liassic Ammonites, by Dr. Wright, COMPLETE	1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885	1878, 1879, 1880, 1881, 1882, 1883, 1884, 1886	503	91	726	107
The Belemnites, by Prof. Phillips, *in course of completion*	1863, 1864, 1866, 1868, 1869	1865, 1866, 1867, 1869, 1870	128	36	622	69
		CARRIED FORWARD...	9654	1176	25,279	4964

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* JANUARY, 1888)—*continued.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		BROUGHT FORWARD...	9654	1176	25,279	4964
The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, COMPLETE	1853, 1854, 1855	1853, 1855, 1857	67	27	319	79
The Fossils of the Permian Formation, by Prof. King, COMPLETE	1849, 1854*e*	1850, 1855	287	29	511	138
The Sirenoid Ganoids, by Prof. Miall, *in course of completion*	1878	1878	32	6	61	6
The Fishes of the Carboniferous Formation, by Dr. Traquair, *in course of completion*	1877	1877	60	7	58	5
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, *in course of completion*	1867, 1869	1868, 1870	62	14	195	21
The Reptilia of the London Clay [and of the Bracklesham and other Tertiary Beds], by Profs. Owen and Bell, Vol. I, COMPLETE ‡	1848, 1849, 1856*f*	1849, 1850, 1859	150	58	304	39
,, ,, Vol. II, Part I, by Prof. Owen, *in course of completion*	1880	1880	4	2	4	1
The Reptilia of the Cretaceous Formations, by Prof. Owen, COMPLETE‡	1851, 1857, 1858, 1862	1851, 1859, 1861, 1864	184	59	519	26
The Reptilia of the Wealden and Purbeck Formations, by Prof. Owen, COMPLETE ‡	1853, 1854, 1855, 1856, 1857, 1858, 1862	1853, 1855, 1857, 1858, 1859, 1861, 1864	155	62	251	17
The Reptilia of the Wealden Formations (Supplements) *in course of completion*	1871, 1873, 1876, 1878, 1879	1872, 1874, 1876, 1878, 1879	81	21	175	15
The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, *in course of completion*	1859, 1860, 1868	1861, 1863, 1869	16	6	23	3
The Reptilia of the Liassic Formations, by Prof. Owen, COMPLETE	1859,‖ 1860,‖ 1863, 1869, 1881*n*	1861, 1863, 1865, 1870, 1881	174	50	276	20
The Reptilia of the Mesozoic Formations, by Prof. Owen, *in course of completion*	1873, 1875, 1877	1874, 1875, 1877	97	24	165	17
The Crag Cetacea, by Prof. Owen, *in course of completion*	1869	1870	40	5	43	7
The Fossil Elephants, by Prof. Leith Adams, COMPLETE	1877, 1879, 1881*n*	1877, 1879, 1881	265	28	216	3
The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and W. A. Sanford, *in course of completion*	1864, 1867, 1868, 1871, 1878, 1886	1866, 1868, 1869, 1872, 1878, 1887	333	39	340	12
The Mammalia of the Mesozoic Formations, by Prof. Owen, COMPLETE	1870	1871	115	4	247	30
		TOTAL	11,776	1617	28,986	5403

a Index. *b* Title-page to Univalves. *c* Note to Crag Mollusca. *d* Contains the Permian. *e* Two corrections of Plates. *f* Supplement.
g Many of the species are described, but not figured. *h* British species only reckoned. *i* British species only reckoned. *k* A Supplement is now in course of publication.
l Index will be found in 1878 vol. *m* Useful for establishing the dates of new species. *n* Contains title-pages and directions for binding.
‡ Title-pages and Index will be found in the 1864 Volume, or may be had separately. ‖ Marked on outside label 'Reptilia of Oolitic Formations.'

§ V. Stratigraphical Table *exhibiting the* British Fossils *already figured and described in the* Annual Volumes (1847—1887) *of the* Palæontographical Society.

	PLANTS.	PROTOZOA.		RADIATA.		ARTICULATA.					
		Sponges.	Foraminifera.	Stromatoporoids and Corals.	Echinodermata.	Cirripedes.	Cypridæ, Cytherinæ, &c.	Phyllopoda.	Merostomata.	Trilobites.	Malacostracous Crustacea.
Pleistocene	...	...	...	...	......	......	1874				
Crag	...	...	1865	1849	1852	1851, 1854					
Eocene	1879, 1880, 1882, 1883, 1884, 1885	...	...	1849, 1865	1852	1851, 1854	1855	...	......	......	1856
Cretaceous.........	...	...	...	1849, 1868, 1869	1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882	1851, 1854	1849	...	......	......	1860
Wealden	...	...	...	...	......	......	...	1860			
Oolitic	...	...	...	1851, 1872	1855, 1856, 1857, 1858, 1861, 1878, 1880	1851	...	1860			
Liassic	...	...	...	1851, 1866, 1867	1855, 1856, 1858, 1861, 1864						
Triassic	...	...	...	...	1880	......	...	1860			
Permian	1849	1849	1849, 1876	1849, 1852	1849	......	1849	1860			
Carboniferous...	1867, 1870, 1871, 1875, 1886	1887	1876	1852	......	......	1874, 1884	1860, 1887	1872, 1878	1883, 1884	
Devonian	...	1887	...	1853, 1885	......	......	...	1860	1865, 1868, 1872, 1878	1862	
Silurian............	...	1886, 1887	...	1854, 1885	......	......	...	1887	1868, 1871, 1872, 1878	1862, 1863, 1864, 1866	
Cambrian	...	1886, 1887	...	...	......	......	...	1887	......	1864	

Note.—The numbers in the above List refer to the Volumes issued for those Dates.

STRATIGRAPHICAL TABLE *exhibiting the* BRITISH FOSSILS *already figured and described in the* ANNUAL VOLUMES (1847—1887) *of the* PALÆONTOGRAPHICAL SOCIETY (*continued*).

	MOLLUSCA.				VERTEBRATA.		
	Polyzoa.	Brachiopoda.	Monomyaria, Dimyaria, and Gasteropoda.	Cephalopoda.	Fishes.	Reptiles.	Mammalia.
Pleistocene	...	1873	......	...	...	......	1864, 1867, 1868, 1871, 1877, 1878, 1879, 1881, 1886
Crag	1857	1852, 1873, 1879	1847, 1850, 1853, 1855, 1871, 1873, 1879, 1882	...	...	......	1869, 1881
Eocene	...	1852, 1873	1852, 1854, 1855, 1858, 1859, 1862, 1870, 1877	1848	...	1848, 1849, 1856, 1880	
Cretaceous.........	...	1852, 1854, 1873, 1884	1872, 1875, 1877, 1879	1853, 1854, 1855	...	1851, 1857, 1858, 1862	
Wealden	...	... ..	......	...	...	1853, 1854, 1855, 1856, 1857, 1862, 1871, 1873, 1875, 1876, 1878, 1879	
Oolitic	...	1850, 1852, 1876, 1878, 1884	1850, 1853, 1854, 1872, 1874, 1875, 1877, 1879, 1883, 1886, 1887	1850, 1861, 1868, 1869, 1886, 1887	...	(Purbeck) 1853, 1858 (Kim. Clay), 1859, 1860, 1868, 1873, 1875, 1877 (Great Oolite) 1875	1870
Liassic	...	1850, 1852, 1876, 1878, 1884	1874, 1877, 1879, 1883	1863, 1864, 1866, 1868, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885,	...	1859, 1860, 1863, 1869, 1873, 1881	
Triassic............	...	1876, 1878	1879	......	1878	......	1870
Permian	1849	1849, 1856, 1880	1849	1849	1849	1849	
Carboniferous ...	...	1856, 1857, 1858, 1859, 1860, 1880, 1884	......	......	1877		
Devonian	...	1862, 1863, 1881, 1882, 1884	......	......	1867, 1869		
Silurian............	...	1865, 1866, 1868, 1870, 1881, 1882, 1883					
Cambrian							

NOTE.—The numbers in the above List refer to the Volumes issued for those Dates.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1887.

LONDON:

MDCCCLXXXVIII.

A MONOGRAPH

OF THE

BRITISH

FOSSIL SPONGES.

BY

GEORGE JENNINGS HINDE, Ph.D., F.G.S.

PART II.

(Pages 93—188; Plate IX.)

LONDON:

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1888.

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PART II.

SPONGES OF THE PALÆOZOIC GROUP.

PRELIMINARY REMARKS.

Up to a comparatively recent period so few genuine fossil Sponges were known from the older stratified rocks of the British area, that it would have been superfluous to devote a separate portion of a Monograph especially to their consideration. Even now the number of species is very limited in comparison with those from the Mesozoic strata, and their state of preservation is very unfavorable; but recent discoveries show that Sponges as a group flourished to such an extent in certain epochs of the Palæozoic era as to form by their remains massive beds of rock of considerable thickness, and, measured by this scale, they were then more numerous than at any subsequent geological period.

In view of this enormous development of Sponge-life, it is reasonable to suppose that the small number of species known hitherto falls far short of those which then existed. In no group of organisms with structures capable of preservation have the influences of fossilisation acted with more destructive effect than upon fossil Sponges; at all events, on those in the Palæozoic rocks; for thick beds occur built up almost exclusively of their remains, and yet not a single entire individual has been preserved in them! Their elaborate skeletal tissues have been altogether disintegrated, and only their minute, microscopical, spicular elements, heterogeneously mingled and cemented together into hard rock, remain for examination.

Under more favorable conditions entire Sponges and fragmentary portions of the connected skeleton are occasionally met with, but at the best the materials for the classification and description of these organisms are very imperfect and unsatisfactory, and such as would be rejected by the student of the living forms as altogether insufficient to furnish generic or specific characters. But since more perfect materials are not available, the palæontologist is compelled to make the most of those which are at his disposal. It will readily be conceded that the

characters of genera and species, based on skeletal fragments or even on detached spicules merely, must be limited and provisional, but at the same time there is no reason to doubt that these fragments and spicules really represent distinct species, and may justly be regarded as such.

Owing to the indefinite ideas formerly held as to the nature of fossil Sponges, it has been my especial endeavour to examine the type specimens of all the species hitherto described. The desirability of this revision of authentic specimens is shown by the long list of bad and doubtful species given in the sequel. Of the total number of reputed species of Palæozoic Sponges up to 1883, I find that only one-third belongs to the group, the remaining two-thirds being either too obscure for determination or pertaining to other organisms.

In the preparation of this part of the Monograph I have received much valuable assistance from numerous friends and fellow-workers, to whom I return my warm acknowledgments. The fossil Sponges preserved in the National Museum at South Kensington, in the collections of the Geological Survey at Jermyn Street, and at Edinburgh, and in the Woodwardian Museum at Cambridge, and the University Museum at Oxford, have freely been placed at my disposal; and to Dr. H. Woodward, F.R.S., Dr. A. Geikie, F.R.S., Prof T. McKenny Hughes, M.A., and Prof. J. Prestwich, F.R.S., my thanks are especially due for the opportunities of studying them. I am also under great obligations to Mr. John Smith, Kilwinning, Mr. John Young, F.G.S., Hunterian Museum, Glasgow, Dr. J. R. S. Hunter, Carluke, and Mr. James Bennie, Edinburgh, for the unstinted loan of their private collections from the Carboniferous series of Scotland; whilst Mr. J. Wright, F.G.S., Belfast, sent me his specimens from the same series in Ireland. Prof. R. J. Anderson, M.A., enabled me to examine the type collection of supposed Permian Sponges described by the late Prof. King, and now in the Museum of Queen's College, Galway. I have also received many specimens, including type forms, from my friend Mr. H. J. Carter, F.R.S., Prof. H. Alleyne Nicholson, F.L.S., Prof. C. Lapworth, F.G.S., Mr. G. H. Morton, F.G.S., Mr. J. Thomson, F.G.S., Glasgow, and the late Mr. A. Champernowne, F.G.S.

General Features of the British Palæozoic Sponges.

Notwithstanding their unfavorable state of preservation, the presence in the British area during Palæozoic times of representatives of the various existing sub-orders of siliceous Sponges can be undoubtedly proved; and, in addition to members of the Monactinellidæ, Tetractinellidæ, Lithistidæ, and Hexactinellidæ, there are other forms, included in the Octactinellidæ and Heteractinellidæ, which are not as yet known later than the Carboniferous period.

The Monactinellidæ are represented by four genera, *Reniera, Axinella, Atractosella*, and *Haplistion.* Entire Sponges and fragments of the connected skeleton of *Haplistion* have been preserved, but the other genera are only represented by detached spicules. These, however, so closely resemble the skeletal-spicules of existing species of these genera, that the generic affinity of the ancient with the recent forms can hardly be doubted. With the exception of the peculiar spicules from the Silurian referred to *Atractosella*, monactinellid Sponges in our area do not appear in force until reaching the Carboniferous. Some of the cherty Sponge-beds in the Yoredale series of Yorkshire and North Wales, and at a corresponding horizon in Sligo, Ireland, mainly consist of the minute, detached, cylindrical spicules of *Reniera,* several species of which appear to be present. The pin-shaped spicules referred to *Axinella* are comparatively rare, and only occur in the Carboniferous; and *Haplistion* is likewise limited to the same formation in the West of Scotland.

The Palæozoic Tetractinellidæ belong to the widely distributed genera, *Geodites* and *Pachastrella.* They are as yet only known by detached acerate, trifid, and four-rayed spicules, and by the reniform spicules of the dermal layer of the former genus. Their first appearance is in the Carboniferous, and they play an important part in building up some of the Sponge-beds of the Yoredale series in Yorkshire. One species, *Geodites deformis*, from the Carboniferous of Ayrshire, is remarkable for the relatively large size of the spicules.

The Lithistidæ are very sparingly represented in our Palæozoic rocks by four genera; of these *Cnemidiastrum* and *Doryderma* are only known by detached spicules. Only a single example of *Astylospongia* has been discovered, and in this the spicular structure has been obliterated so that its identification is not altogether certain. The genus is of such common occurrence in the Silurian strata of North America and the Isle of Gothland, that its comparative absence in the British area is worthy of note. The genus *Hindia*, again, which has a similar wide distribution, is only known in this country by a single fragment lately discovered in the Ordovician strata of Ayrshire, and some detached spicules in the Carboniferous Rocks. Another well-marked Silurian genus, *Aulocopium*, Oswald, very abundant in the Baltic basin, is entirely absent in this country.

Hexactinellid Sponges are by far the most numerous in the Palæozoic strata. Twelve genera belonging to this sub-order are known, some, however, only from detached spicules or small fragments of the connected skeleton. The earliest known fossil Sponge, *Protospongia fenestrata*, Salter, from the Menevian beds of South Wales, is included in this sub-order. The genus *Hyalostelia* is the most widely distributed; it is present in every division of the Palæozoic Rocks, except the Devonian. The Sponges of this genus, like the existing *Hyalonema*, were furnished with bundles or wisps of elongated rod-like spicules which served to

attach the organism to the sea bottom. These bundles of anchoring spicules are more frequently preserved than the six-rayed spicules of the body of the Sponge, and they have been found in the Tremadoc rocks of Wales, and the Ordovician of Girvan, Ayrshire; but they are more particularly abundant in the Sponge-beds of the Yoredale series in Yorkshire and in the decayed chert of the corresponding rocks in the West of Scotland and Ireland. Entire beds of rock in Yorkshire are filled with them.

The genus *Dictyophyton* is only represented by a small form, which appears to be limited to Ludlow strata near Kendal, whilst it seems to be entirely absent from the Devonian strata in this country. In North America, on the other hand, and in Belgium, this genus has a great development in the Upper Devonian.

Plectoderma is as yet only known by a fragment of the connected skeleton, it is limited to the Upper Silurian of the Pentland Hills. *Phormosella* is likewise restricted to a single horizon of the Silurian in Shropshire. Like many of the Palæozoic hexactinellids, it appears to have been a gregarious form.

Whilst the spicular characters of many of the Palæozoic hexactinellids correspond closely with those of existing Sponges of this division, there are others in which the spicules are greatly modified, and widely diverge from the normal type. Thus in the Carboniferous genus *Spiractinella*, Hinde, the rays are ornamented with a spiral ridge; and, though simple six-rayed spicules occur, in the majority the rays divide and subdivide, so that the extreme forms are stellate. In *Holasterella*, Carter, stellate spicules are likewise present, and the larger spicules of the skeleton also appear to be very irregular in form. Still more abnormal are the large branched and spined spicules of *Acanthactinella*, Hinde, from the Carboniferous of Ayrshire. In *Amphispongia* again, limited to a single horizon of Upper Ludlow age, and to a single locality in the Pentland Hills, the spicular structure strikingly differs from that of any other hexactinellid genus. In the well-marked family of the Receptaculitidæ, one ray of the normal hexactinellid spicule is modified into a delicate plate.

Only detached spicules of the genus *Astræospongia* have as yet been met with in the Silurian and Devonian strata of Shropshire and Devonshire, though in North America, and in Germany, entire Sponges are occasionally preserved.

The most striking of any of the Palæozoic Sponges are the forms which I have described under *Tholiasterella* and *Asteractinella*, and placed in a new sub-order, the Heteractinellidæ. Their spicules are of unusually large dimensions; the number of rays is variable, ranging from six to thirty, and they are disposed so as to form either stellate or umbrella-shaped spicules. The spicules appear to have been partially free and partially fused together in the skeleton. These remarkable forms have as yet only been found in the Carboniferous Rocks of Ayrshire.

The only examples of the *Calcispongiæ* yet discovered in our area are minute detached spicules in the Carboniferous Rocks of Fifeshire.

Geological Distribution.

Cambrian System.—The lowest rocks in which fossil Sponges have been met with are hard, black, slaty beds, belonging to the Menevian series near St. David's, South Wales. The examples of *Protospongia* occurring in them, have their spicules replaced by iron-pyrites or iron-peroxide. The same genus is present in nearly similar rocks at Krekling and other places in Norway, associated with *Paradoxides.*

In hard, slaty rock of the Tremadoc series, near St. David's, the earliest known example of *Hyalostelia* was discovered by Dr. Hicks, F.R.S.

Ordovician System.—In the Llandeilo district of North Wales, at Tre Gil, South of Llandeilo, Pont Ladies, and near Shelve, in Shropshire, the anchoring spicules of *Hyalostelia* are of not unfrequent occurrence in the hard, dark, calcareous shales of the Llandeilo series. The same genus is present in a dark slaty rock at Dobb's Linn, Moffat, Dumfriesshire, as well as in light grey limestones of Ordovician age, in the Girvan area of Ayrshire; and from the same rocks Professor H. A. Nicholson has obtained *Hindia fibrosa*, Roemer. In a slaty rock of Lower-Llandeilo age at Garn, Arenig, Wales, *Ischadites* makes its first appearance. The Caradoc shale of Haverfordwest, South Wales, has yielded a single pyritized example of *Astylospongia.*

Silurian System.—Alike in the calcareous shales of the Wenlock and Ludlow series, the genus *Ischadites* is widely distributed. At Woolhope, in the Dudley and Malvern areas, Usk, near Buildwas, Shropshire, examples have been met with.

In the Dudley and Malvern areas, spicules of *Astræospongia* are sparsely present, and near the "Craven Arms," Shropshire, *Hyalostelia* and *Atractosella* are found in decayed limestones.

A well-marked horizon for fossil Sponges occurs in the Pentland Hills, near Edinburgh. The rock is a decayed limestone of Upper-Ludlow age. It is characterised by *Amphispongia;* examples of *Plectoderma* and *Ischadites* also are present in it. At Mocktree, Shropshire, a sandy rock of Aymestry age is characterised by *Phormosella;* and the only British examples of *Dictyophyton* have been met with in arenaceous beds of Upper-Ludlow age, near Kendal, Westmoreland.

Devonian System.—In the limestones of the typical area of this system, at Newton Bushell, Devonshire, *Sphærospongia* occurs; at the adjacent Newton Abbot detached spicules of *Astræospongia* are present in decayed limestones, and at Mud-

stone Bay a single specimen of *Receptaculites* was discovered by the late Mr. Champernowne.

Carboniferous System.—In the earlier rocks of the Palæozoic group, fossil Sponges are, as a rule, of rare occurrence, and they are altogether insufficient to impress a distinctive character on the rocks in which they are found, but in certain portions of the Carboniferous epoch they existed in such great numbers, and for such prolonged periods, that by the gradual accumulation of their broken-up skeletons beds of chert and siliceous rock of considerable thickness have been formed. Owing to the microscopic dimensions of the elementary spicules of which these rocks are mainly composed, and to the fact that subsequent changes have greatly altered and partially obliterated their original characters, the organic origin of these rocks, though oftentimes suspected, has not hitherto been satisfactorily ascertained. But from a microscopical examination of specimens which I have myself obtained from the chert and siliceous rocks of the Yoredale series of Yorkshire and North Wales, and from the corresponding horizon in Ireland, I have discovered that these rocks are composed of the débris of siliceous Sponges, and that they are veritable Sponge-beds.

In some cases these Sponge-beds occur as irregular, nodular masses, or accretions of grey or dark chert, in the midst of beds of limestone, resembling in appearance flints in chalk ; in others, the chert forms distinct beds, often variously banded, from one or two inches to eight feet in thickness (·025—2·43 m.). These chert beds appear to be free from limestone. Frequently, however, the Sponge-beds assume the form of grey or dark, compact, fine-grained siliceous rocks, distinctly bedded, and often having a mottled or banded structure. Occasionally a small proportion of lime is present in them.

Only exceptionally are the spicular contents of these rocks visible to the unaided sight, in the majority of cases they can only be seen in thin sections under the microscope or with the aid of a platyscopic or other good lens. Thin sections of the least altered specimens show a confused mass of spicules of various forms and sizes, thickly and indiscriminately mingled together, but usually with a generally horizontal arrangement in the plane of the rock-bedding. These spicules appear to be perfect in form, and their axial canals in many cases have been preserved. In general, however, they have been altered in various degrees by the effects of fossilization, so that it is possible in a series of sections, or even in different parts of the same section, to trace the gradual changes from rocks filled with spicules nearly in their original condition, to those in which they have become merged into a matrix of translucent silica, leaving but few traces of their former presence.

It is difficult to ascertain the characters of the spicules merely from sections of the rocks, but in a few cases the cherty Sponge-beds have decayed in such a manner that their component spicules, or at least the larger forms, can be obtained

free from the matrix; and it is from decayed material of this description that Mr. J. Smith, Mr. John Young, and Mr. J. Bennie have obtained the remarkable spicules of *Hyalostelia*, *Tholiasterella*, and other genera (Pls. VI, VII, VIII), and Mr. J. Wright those of *Spiractinella* (Pl. VIII). Not infrequently also the spicules on the outer portions of the Sponge-beds weather out naturally so that their forms can be ascertained.

In some of the Sponge-beds the anchoring- and body-spicules of hexactinellid Sponges appear to predominate; other beds are mainly made up of very minute acerate and cylindrical spicules of monactinellid Sponges, whilst in others, larger acerates and occasional trifid spicules indicate that tetractinellid Sponges contributed largely to the contents of the bed.

The Carboniferous Sponge-beds referred to above are principally developed in the upper portion of the Yoredale series, between the summit of the Carboniferous Limestone proper and the base of the Millstone-grit. Bands and nodules of chert also occur in the Carboniferous Limestone, and some which I have examined are filled with spicules, like those in the series above.

YORKSHIRE.—In the higher districts of Swaledale, Wensleydale, and Arkendale, in the north-west of Yorkshire,[1] the chert and siliceous rocks, composed of Sponge remains, are well-known and persistent portions of the Yoredale series, and from the fact that in common with the associated limestone and other rocks they are traversed in places by veins of lead-ore which have been largely worked, the various beds have been recognised by distinctive names. Thus the upper beds are known as the "Red-Beds Chert," and below these and separated from them and from each other by intervening beds of limestone, shale, and sandstone, are the "Black-Beds Chert," the "Main Chert," and the "Undersett Chert." The thickness of these different chert-beds varies in different sections.

The "Undersett Chert" exposed in the bed of the Swale, both below and above Keld, appears to be from 15 to 20 feet (4·5 to 6 m.) in thickness. It is here a dark, compact, brittle chert. In a railway-cutting near Leyburn, in Wensleydale, the "Undersett" is 10 feet (3 m.) in thickness. The chert here is greyish, distinctly banded, and filled with spicules. The "Main Chert" is well shown at Arkendale, on the south side of the valley; in the upper portion of Gunnerside Gill, in Swaledale; east of Leyburn in Wensleydale, as well as other places in the district. It more frequently consists of a compact, dark grey mottled, siliceous rock, rather than a true chert. The beds are continuous, with a total thickness of about 18 feet (5·4 m.). The "Black Beds" and "Red Beds Chert" are not so well exposed as the beds beneath them, but according to

[1] For much of the information respecting the distribution and the best exposures of the cherty rocks in this area I am indebted to Mr. J. G. Goodchild, F.G.S., of the Geological Survey.

Prof. Phillips[1] the thickness of these two upper series of beds in Arkendale and Swaledale varies between 36 and 54 feet (10·8—16·2 m.).

Lower down the Swale valley, and more particularly at Richmond (Yorkshire), chert-beds of the same character are frequently exposed. In quarries above Richmond there are numerous thin beds of chert and siliceous rock alternating with crinoidal limestones, probably forming part of the "Red Beds." In the section exposed, 34 feet in thickness, there are in all 9½ feet of the siliceous rocks or Sponge-beds, which are filled with well-preserved spicules.

Judging from the data given by Prof. Phillips, and from my own observation, I should estimate that the Sponge-beds of Swaledale and Yoredale reach a total thickness of between 70 and 90 feet (21—27 m.).

In a quarry near Harrogate, in the so-called "Road-Stone," there are two beds of chert with a thickness together of two feet. The spicules are well shown in these beds.

Lancashire.—Thin bands and patches of dark chert filled with spicules are present in the Carboniferous Limestone exposed in the quarries near Clitheroe, and thin bands of siliceous shale between the beds of limestone contain detached spicules of *Hyalostelia*, *Geodites*, and *Reniera*.

North Wales.—In Flintshire there is a continuous series of chert-beds, which, as shown by the borings of the lead-mines, reach the extraordinary thickness of 350 feet[2] (105 m.). The beds are best exposed at Halkin and Henblas, near Holywell, and also at Trelogan and Gronant, near Prestatyn. They occur at the same geological horizon as the Sponge-beds of the Yoredale series in Yorkshire, that is, between the Carboniferous Limestone proper and the true Millstone-grit; but on the alleged grounds of a gradual lithological passage between the chert-beds and veritable Millstone-grit,[3] Mr. J. A. Strahan, F.G.S., who has lately surveyed the district, has included them as part of this latter division; whilst Mr. G. H. Morton, F.G.S.,[4] regards them as Carboniferous Sandstone. Neither of these geologists recognised the organic nature of the rock. Mr. Strahan has described the chert as "probably a siliceous sediment of extreme fineness," and Mr. Morton regards the strata as originally of sandstone, which has been, for the most part, converted into chert.

Microscopic sections of the chert collected from the different outcrops show the presence of the same spicules as in the Yorkshire beds, and that this remarkable series of chert rocks are built up of the integrated skeletons of siliceous Sponges. As a rule, the spicules in these Flintshire cherts are not so favorably preserved

[1] 'Geology of Yorkshire,' part ii, p. 66.

[2] 'Mem. of the Geol. Survey, Explanation of Quarter-Sheet 79 N.-W.,' p. 18.

[3] Op. cit., p. 18.

[4] 'Proc. Liverpool Geol. Soc.,' vol. iv, pt. v, 1882-3, p. 393.

as those of the Yorkshire beds, but the same forms of *Hyalostelia* and *Reniera* can be recognised in them.

At the head of the Gwydfyd Valley, on the Great Orme's Head, there are portions of broken-up beds of white and bluish cherty rocks, which have been described by Mr. George Maw, F.L.S.,[1] and estimated by him to be about 50 feet in thickness. They apparently belong to the series above the Carboniferous Limestone; the fragments are filled with spicules, principally minute acerates, similar to those in the beds at Gronant.

Scotland.—The beds which have yielded the remarkable series of Sponge remains in Ayrshire, belong to what is known as the Upper-Limestone and Lower-Limestone series of the Scotch geologists, which are situated beneath the Millstone-grit, and thus on the horizon corresponding to the Yoredale series of Yorkshire and North Wales, in which Sponge-beds are so largely developed.

In Ayrshire, however, the Sponge-remains[2] have principally been obtained from decayed material in the joints and fissures in the limestone, and in soft, siliceous clays infilling irregular cavities in the same rock. Mr. John Smith, of Kilwinning, has supplied me with the following list of localities in Ayrshire which have yielded Sponge-spicules; Stacklawhill, thirty feet above the Linn-Spout Limestone; Glencart, Lambridden, Linn Spout, and Monkcastle, in the Upper-Limestone series; Birkhead, Thirdpart, Blackstones, Cunningham Baidland, Low Baidland, Law, and Auchenskeith, in the upper part of the Lower-Limestone series; and Crawfield in the lower part of the same series. Other localities are Dockra, Hillhead, near Beith, and Dunlop, Ayrshire. They have also been met with in the limestones at Corrieburn, Campsie Hills, near Kirkcaldy, Fifeshire, near Linlithgow, Charlestown Quarry near Inverkeithing, Roscobie Quarry, near Dunfermline, Macbiehil, Peebles, near Cupar, and near Dalkeith. The forms most widely distributed are the anchoring spicules of *Hyalostelia* and the cylindrical spicules of *Reniera;* in the Ayrshire district these are accompanied by the remarkably large spicules of *Geodites*, *Asteractinella*, *Tholiasterella*, and *Acanthactinella.* Though the beds of Sponge remains in Scotland are of much less thickness than those of Yorkshire and North Wales, yet, owing to the preservation of the spicules in loose materials, they have yielded a greater number of species.

Ireland.—A well-marked series of Sponge-beds, hardly inferior in importance to those of Yorkshire and North Wales, is developed in the so-called Upper Limestone of the Carboniferous series of the Irish Geological Survey. The Sponge-beds principally occur in the higher portions of the Upper Limestone, and they have been included with this as the equivalents of the Carboniferous or Mountain Lime-

[1] 'Geol. Mag.,' vol. ii, 1865, p. 200.

[2] 'Catalogue of the Western-Scottish Fossils,' 1876, p. 36; also 'Proc. Nat. Hist. Soc. Glasgow,' 1882, p. 234.

stone of England, whilst the overlying shales and sandstones between them and the Millstone-grit are regarded by Prof. Hull[1] as corresponding to the Yoredale-beds. As, however, the Sponge-beds consist of chert, closely resembling that of the Yoredale series in England and North Wales, it is reasonable to conclude that they may occupy a corresponding horizon, even though no well-marked line of demarcation between them and the main mass of the Carboniferous Limestone has up to the present been noted.

The Sponge-beds chiefly occur as nodular masses or bands of dark, mottled, compact chert, closely similar to those of Yorkshire and North Wales.[2] Microscopic sections of specimens which I have lately collected from various outcrops of the rock in Queen's County and Kilkenny to the south, and in Fermanagh and Sligo to the north-west of Ireland, all show the presence of spicules, and distinctly prove that the rock has been derived from them.

Well-marked beds of chert, from one to three inches in thickness (·025—·075 m.), are also frequently present in the dark limestones of the Calp or Middle series of the Carboniferous Limestone in the neighbourhood of Dublin, and these, like the higher beds, are filled with microscopic spicules.

Owing to the irregular manner in which the nodular masses and bands of chert, constituting the Sponge-beds, are intercalated in the limestones of the Upper Series in Ireland, it is difficult to form an estimate of their total thickness. In Queen's County and Kildare the chert layers are stated[3] by the late Professor Jukes and Mr. Kinahan to be sometimes so frequent that they make the rock nearly an entire mass of chert. In the ridge west of Carlow the greyish chert is stated to be over 30 or 40 feet in thickness.[4] At Florence Court, near Enniskillen, Professor Hull[5] estimates that the chert bands in the Upper Limestones have a total thickness of perhaps 150 feet (45 m.); but from my own observation this estimate seems considerably too high.

[1] 'Scientific Trans. Roy. Dublin Soc.,' vol. i, N. S., 1878, p. 73.

[2] In a recently published paper ('Proc. Royal Soc.,' vol. xlii, 1887, pp. 304—308) Prof. Hull, F.R.S., the Director of the Irish Geological Survey, most emphatically combated a suggestion made by me two years since, that the chert bands of the Irish Carboniferous Limestone were probably derived from Sponge-spicules, the same as the chert beds of the Cretaceous strata of the south of England ('Phil. Trans.,' 1885, pt. ii, p. 433).

After the publication of this paper I went to Ireland and examined the chert beds in the various localities from whence Prof. Hull had obtained the specimens on which he based his conclusions, and I then found that there was decisive evidence that they were derived from Sponge remains as I had suggested ('Geol. Mag.,' n. s., dec. iii, vol. iv, p. 44). An inspection of the microscopic sections which Prof. Hull described and figured showed, as Prof. Sollas had already stated ('Ann. and Mag. Nat. Hist.,' vol. vii, 1881, p. 141), that some of them were largely composed of spicules.

[3] 'Geol. Surv. Ireland, Explanation Sheet 128,' p. 12, also quoted by Prof. Hull, op. cit., p. 75.

[4] 'Scientific Trans. Roy. Dublin Soc.,' vol. i, N. S., 1878, p. 75.

[5] 'Proc. Royal Soc.,' vol. xlii, p. 306, Note.

The chert beds are well developed in the Upper-Limestone series of the County of Sligo; more especially at the hill of Keishcorran near Ballymote, on the higher slopes of Knock-na-Rea, near the town of Sligo, and in the ridge of Ben Bulben to the north of Sligo Bay. The separate bands of chert vary from one to five inches in thickness, with intervening layers of blue limestone. The chert bands are frequent, and I should judge that in different places they form from one-tenth to one-fifth of the total mass of the rock. Beds of siliceous clay—probably resulting from decayed chert—and like the material in the Ayrshire deposits, filled with loose spicules, have been met with near the summit of Ben Bulben, and their contents described by Mr. H. J. Carter, F.R.S.[1]

It is evident that to produce the enormous accumulation of spicules sufficient to build up beds of rock like those referred to in Yorkshire, North Wales, and Ireland, reaching in one place a maximum thickness of 350 feet (105 m.),[2] Sponge life must have been extremely abundant and persistent in the Carboniferous epoch, more so, perhaps, than at any subsequent period. It is true that the number of species yet recognised from these thick deposits of Sponge remains is comparatively limited, but it is hardly safe to conclude from this fact that there was but little variety of form in the group at this period, for, owing to the general and complete manner in which the Sponge-skeletons have been reduced into their component elements, and their unfavorable condition of preservation, all other generic and specific characters, beyond those of the form and proportions of the individual spicules, have been obliterated. The fact that not a single example of an entire Sponge has been up to the present discovered in any of the Sponge-beds of Yorkshire, North Wales, and Ireland is a striking proof of the complete manner in which their skeletons have been broken up. In this respect fossil Sponges have undergone the same reducing process as the Crinoids, of whose remains the massive beds of limestones in the Yoredale series mainly consist. Whilst in the limestones we rarely meet with more than the disarticulated joints and plates of the stems and calyces of Crinoids, in the chert and siliceous rocks intercalated with

[1] 'Ann. and Mag. Nat. Hist.,' ser. 5, vol. vi, 1880, p. 209.

[2] Professor Sollas has lately stated that the extraordinary profusion of Sponge-spicules in modern marine deposits and in the ancient stratified rocks is due to the fact that the living Sponge is constantly producing and disengaging spicules, and that during the process of "growth the spicule slowly passes from the interior to the exterior of the sponge, and is finally, in at least some Sponges (*Geodia, Stelletta*), cast out as an effete product" ("Sponges," 'Encyclopædia Britannica,' ninth edition, vol. xxii, p. 420). Hitherto these deposits of Sponge remains have always been regarded as arising from the disintegration of their skeletons after the death of the Sponge, and this still seems to me the more probable explanation. Prof. Sollas' statement is so marvellous that it will require strong confirmatory evidence before it can be accepted. At present none is given, and the general experience of other observers points in an opposite direction, viz. that in the growth of the Sponge the skeletal-spicules gradually tend to become firmer and more deeply embedded in the living tissues of the organism.

the limestones only the microscopic detached skeletal-spicules of Sponges have been preserved.

Permian System.—It is doubtful whether any genuine fossil Sponges have as yet been discovered in the strata of this system in the British area; those described as such by the late Prof. King[1] prove, on examination, to be either organisms of very problematical character or inorganic concretions. The forms described as Sponges by Prof. Geinitz[2] from the corresponding Dyas of Germany, are of an equally dubious character.

[1] 'Monog. of the Permian Fossils,' Pal. Soc., 1849, pp. 11—14.

[2] 'Die animalischen Ueberreste der Dyas,' 1861, pp. 123-4, pl. xx.

DESCRIPTION OF GENERA AND SPECIES.

CAMBRIAN SPONGES.

Sub-Order.—Hexactinellidæ.

Family.—Protospongidæ.

Genus.—Protospongia, *Salter.*

1864. 'Quart. Journ. Geol. Soc.,' vol. xx, p. 238.

Generic Characters.—Sponges probably cup- or vase-shaped, with walls consisting apparently of a single layer of spicular mesh. This is composed of cruciform spicules of varying dimensions; the larger are arranged so as to form a regular quadrate framework, which is divided into secondary squares by smaller spicules, and these are again subdivided in a similar manner, so that, when complete, there are four or five series of squares. The spicular rays appear to have been organically cemented together at their points of junction with each other, and there are traces of a delicate membrane in the interstitial areas between the rays, which may have united the entire meshwork together.

No other structures beyond the wall of spicular framework have as yet been discovered, and it may be presumed that this constituted the entire skeleton of the Sponge.

This genus is, apparently, most nearly related to *Dictyophyton*, Hall, in which the Sponge-wall is similarly constituted of larger and subordinate squares; but hitherto the spicular structure of these squares has not been described, and it is quite possible that it may not have been of cruciform spicules like those of *Protospongia*. From *Phormosella*, Hinde, the present genus is distinguished by the regular arrangement of the larger and smaller squares of the meshwork, and from *Plectoderma*, Hinde, by the simple, nonfasciculate disposition of the spicules.

Mr. Salter defined the skeleton of this genus as "loosely reticular, formed of very large cruciform spiculæ, the branches of which cross each other at an angle of 80°, and only in one plane, no ascending or descending branches rising from the

point of conjunction." This view of the spicular character of the skeleton was much nearer the truth than that of Dr. Bowerbank, who stated that the structures were not spicules, but horny fibres replaced by pyrites.[1]

Different opinions are held as to whether the spicules in this genus were free, and merely held in position by the soft structures of the animal, or whether they were organically attached together by a deposition of silica at the junction of the rays with each other. So far as I have been able to judge from the few instances in which the spicular rays are seen in contact, they appear to have been cemented or fused together at their junction with each other, though there is not that complete coalescence of the adjacent rays which exists in regular Dictyonine hexactinellids. The spicular rays do not interlace with each other sufficiently to account for the preservation of connected portions of the meshwork in the fossil state, and without a certain degree of organic attachment they would, almost inevitably, have fallen entirely apart from each other. The fusion of the rays at their points of contact does not, however, appear to have been sufficiently strong to prevent that partial disruption of the spicular wall which has taken place in most of the examples, or the isolation of the larger spicules in many cases.

1. Protospongia fenestrata, *Salter*. Pl. I, figs. 1, 1 *a*.

1864.	Protospongia	fenestrata,	*Salter*.	Quart. Journ. Geol. Soc., vol. xx, p. 238, pl. xiii, figs. 12 *a*, *b*.
1873.	—	—	—	Cat. Cambrian and Sil. Foss. Cambridge, p. 3.
1877.	—	—	*Zittel*.	Studien, Ab. 1, p. 45; Königl. bayer. Akad. der Wiss., Cl. ii, Bd. xiii, Ab. 1; Neues Jahrbuch, p. 354.
1877.	—	—	*Carter*.	Ann. and Mag. Nat. Hist., ser. 4, vol. xx, p. 177.
1880.	—	—	*F. Roemer* (in part).	Lethæa palæozoica, Th. 1, p. 316, fig. 59 *a*.
1881.	—	—	*Etheridge, senr*.	Mem. Geol. Surv., vol. iii, 2nd ed., Appendix, p. 472.
1882.	—	—	*Zittel*.	Neues Jahrb., Bd. ii, p. 203.
1883.	—	—	*Hinde*.	Catalogue Foss. Sponges, p. 129, pl. xxviii, fig. 2.

The fragments of the wall of this species which have been preserved are insufficient to indicate the probable form of the Sponge. The cruciform spicules

[1] 'Quart. Journ. Geol. Soc.,' vol. xx, p. 239.

forming the skeletal mesh are of a delicate character, the rays are circular in section and nearly of an even thickness throughout their length. It is probable that the spicules were originally rectangular, but in the type specimen the rays are now oblique, owing to the distortion produced by the compression of the rock matrix. There are five different series of squares in the Sponge-wall, the rays bounding the largest squares are 8 mm. in length by ·2 mm. in thickness, whilst the rays forming the secondary and smaller squares are 4 mm., 2, 1, and ·5 mm. in length respectively. The junction of the rays with each other is, in no case, distinctly shown; they can be traced nearly to the point of contact, and do not apparently overlap the squares in which they are situated.

The typical example of this species, now in the British Museum, exhibits a fragment of the Sponge-wall on the surface of a slab of hard black shale. The original silica of the spicules has been replaced by iron-pyrites, and a delicate film of this mineral extends over the surface of the Sponge, and is probably a replacement of a siliceous dermal membrane, which served in part to hold the spicular mesh together. Not only is the spicular framework distorted, but in all the specimens I have seen it is partially broken up and many of the spicules absent or displaced.

This species differs from *Protospongia Hicksi* in the much more slender character of the spicular mesh, which is very clearly shown in the figures of the two species on Plate I.

Distribution.—Cambrian: Menevian Group, St. David's, South Wales; Lower Lingula Beds, Tyddyngwladis, Upper Mawddach, North Wales.

2. Protospongia Hicksi, *Hinde sp. nov.* Pl. I, figs. 2, 2 *a*.

1871. Protospongia fenestrata, *Hicks.* Quart. Journ. Geol. Soc., vol. xxvii, p. 401, pl. xvi, fig. 20.
1878. — — *Brögger.* Om paradoxidesskifrene ved Krekling, Nyt. Mag. f. Naturvidensk., vol. xxiv, p. 36, pl. vi, fig. 14.
1880. — — *F. Roemer* (in part). Lethæa palæozoica, Th. 1, p. 316, fig. 59 *b*.
1880. — — *Sollas.* Quart. Journ. Geol. Soc., vol. xxxvi, p. 362, fig. 1.
1884. — — *Walcott.* Pal. of the Eureka District, United States Geol. Surv., vol. viii, p. 10, pl. ix, figs. 5 *a*, *b*.

Sponge probably vasiform; the portions preserved indicate that the type specimen was at least 100 mm. in height by 75 mm. in width at the summit. The

spicular mesh is composed of robust cruciform spicules, the rays are approximately rectangular, and nearly of a uniform thickness throughout their length. The centres of the spicules are slightly elevated, so that they are not strictly horizontal. The rays of the smaller spicules in the majority of cases dip beneath those of the larger forms. Five series of squares are present in the complete mesh, the largest are 8 mm. in diameter and the smallest ·5 mm.; the axes of the largest spicules are 16 mm. in length and ·52 mm. in thickness, whilst the smallest are 1 mm. in length and ·2 mm. in thickness.

The typical example of this species, now in the Woodwardian Museum at Cambridge, is preserved on a block of black slate. The spicular mesh has been replaced by iron-pyrites; in places it stands boldly out from the rock surface. Though the regular arrangement of the spicules of the mesh is clearly shown in only one portion of the specimen, it can be traced over an extended surface, and it occurs at two different levels separated by an interval of matrix, of about 4 mm. in thickness. This appears to me to indicate that the entire Sponge was vasiform or cup-shaped, and that, owing to pressure, the opposite walls of the cup are now nearly in contact with each other.

The original specimen was discovered by Dr. H. Hicks, F.R.S., who referred it to *P. fenestrata,* Salter. It was subsequently described in considerable detail by Prof. Sollas, who also regarded it as identical with Salter's species. A comparison of this form with the type of *P. fenestrata* shows, however, a very considerable difference in the thickness of the spicular rays, sufficient to indicate it as a distinct species, which I have named in honour of its discoverer.

In no case in this specimen are the points of contact of the spicules with each other clearly shown, but the structure of the mesh appears to me to justify the view that the spicules are cemented together where they join each other; Prof. Sollas states, however, that they are separated and not united either by envelopment in a common coating or by ankylosis.

Fragments of mesh and detached cruciform spicules, apparently belonging to this species, have been discovered in Norway, Sweden, and also in Nevada, at approximately the same geological horizon.

Distribution.—Cambrian; Menevian Group. Porth-y-Rhaw, near St. David's, South Wales. Cambrian; Paradoxides-Shales, Krekling, Norway (Brögger); at Andrarum, Sweden, in beds with *Paradoxides* and *Agnostus pisiformis;* Eureka district, Nevada, in the Prospect Mountain Group (Walcott).

Group.—LYSSAKINA.

Family.—POLLAKIDÆ.

Genus.—HYALOSTELIA, *Zittel*; Emend. Hinde.

1878. Handbuch der Palæontologie, Bd. i, Lief. 2, p. 185.

Syn.—Pyritonema, *M'Coy;* Acestra, *F. Roemer;* Acanthospongia, *Young* (non *M'Coy*); Hyalonema, *Young, Carter* (in part); Serpula, *Portlock*, *M'Coy* (in part); Astroconia ? *Sollas.*

Generic Characters.—Complete form of Sponge unknown; the body-portion is composed partly of simple hexactinellid spicules in which one axis is usually much elongated, and partly of spicules in which one or more of the rays are inflated, spined, reduced to rounded knobs, or even absent. The dermal layer is mainly formed of large spicules in which the distal ray is reduced to a blunted process. The anchoring appendage consists of elongated, cylindrical, rod-like spicules, which are either separate, or in rope-like bundles, and sometimes terminate in four recurved rays.

This genus was based by Prof. Zittel on the characters of *Hyalonema Smithii*, as described by Messrs. Young and Young.[1] These authors, however, included in the type-species a great variety of forms of detached spicules, some of which belong to distinct genera. Thus, for example, the spicules with from six to eight horizontal rays, mentioned in Zittel's diagnosis of the genus, do not belong to the same Sponge as the simple hexactinellid spicules. This has been proved by the subsequent discovery of fragments of spicular mesh, in some of which hexactinellid spicules and their modifications are exclusively present, whilst others are composed only of the umbrella-shaped spicules with numerous horizontal rays.[2] I have therefore proposed that the skeletal-spicules in *Hyalostelia Smithii*, which has been taken as the type of the genus, should be restricted to such simple and modified hexactinellids as are present in the connected fragments of skeleton, and that the umbrella- and stellate-spicules should be excluded from it. The body-spicules do not appear to have been originally attached together in any way; those occurring in the fragments of the skeleton which have been met with are held together by a secondary deposit of silica.

The elongated anchoring spicules of the Sponge are present in great abundance in the same beds with the body-spicules, and are therefore assumed to have

[1] 'Ann. and Mag. Nat. Hist.,' ser. 4, vol. xx, p. 425, pls. xiv, xv.

[2] 'Cat. Foss. Sponges,' p. 150.

belonged to the same Sponge. In some instances, however, the spicular ropes and detached spicules occur in beds in which no hexactinellid spicules have as yet been met with; but this may in part be accounted for by the fact that even during the life of the Sponge the anchoring spicules would be buried in the bottom ooze, and would thus escape the disturbing influences which have probably scattered and destroyed the body-spicules after the death of the Sponge.

These anchoring spicules, in the best preserved examples, exhibit all the characters of similar spicules in recent hexactinellid Sponges met with in deep-sea dredgings. They are composed of silica deposited in concentric layers, they are traversed by an axial canal, and many of them likewise terminate in four recurved hooks. Further, in one species the surface of many of these spicules is ornamented with slight projecting frills of a character similar to those present in the anchoring spicules of the recent *Hyalonema mirabile*, Gray. As the recent anchoring spicules are in all cases associated with a Sponge body consisting of hexactinellid spicules, it may be concluded that the fossil anchoring spicules were similarly associated, even though they now occur in beds in which the hexactinellid body-spicules are rare or apparently absent.

Pyritonema, M'Coy, and *Acestra*, F. Roemer, have been founded exclusively on the bundles of anchoring spicules. On the ground of priority, M'Coy's term might be claimed as the designation of this genus, but as objection could be taken to employing it for hexactinellid body-spicules as well as for the anchoring spicules, it seems preferable to adopt Zittel's name *Hyalostelia*, which includes both kinds of spicules.

Both M'Coy and Portlock regarded the anchoring spicules occurring in the Carboniferous Limestone of Ireland as the tubes of annelids, and placed them in the genus *Serpula*.

Hyalostelia is first known in Cambrian strata (Tremadoc Group), and it is also present in Ordovician, Silurian, and Lower-Carboniferous Rocks. Detached hexactinellid spicules in the Upper Chalk have been assigned to the genus, but the ropes or bands of anchoring spicules have not been met with above the Carboniferous Rocks.

3. Hyalostelia fasciculus, *M'Coy* sp. Plate I, figs. 3, 3 *a*, 3 *b*.

1850.	Pyritonema fasciculus,	*M'Coy.*	Ann. and Mag. Nat. Hist., ser. ii, vol. vi, p. 273.
1854.	— —	*Morris.*	Cat. Brit. Foss., p. 63.
1855.	— —	*M'Coy.*	Brit. Pal. Foss., p. 10, pl. i B, fig. 13.
1869.	Eophyton explanatum,	*Hicks.*	Geol. Mag., vol. vi, p. 534, pl. xx, figs. 1 *a—e*.

1873.	PYRITONEMA FASCICULUS, *Salter.*	Cat. Cambrian and Silur. Foss. Cambridge, p. 30.
1881.	EOPHYTON ? EXPLANATUM, *Nathorst.*	Om spår af nagra evertebrade djûr, &c., Kong. Svenska vetensk. Akad. Handl., Bd. 18, No. 7, p. 46.
1881.	— — *Hicks.*	Quart. Journ. Geol. Soc., vol. xxxvii, p. 490.
1883.	HYALOSTELIA FASCICULUS, *Hinde.*	Cat. Foss. Sponges, p. 151.
1886.	— — —	Geol. Mag., dec. iii, vol. iii, p. 337, fig. 1.

No hexactinellid body-spicules are as yet known in connection with this species, which is founded exclusively upon fragments of the bundles of spicular rods forming the anchoring appendages of the Sponge. In some examples the bundles occur as narrow, nearly straight bands of indefinite length; the longest specimen known is 140 mm. in length, from 5 to 6 mm. in width, and with a thickness varying from ·5 to 2 mm.; in others they resemble stout ropes, from 20 to 25 mm. in thickness. The individual rods composing these bundles are, for the most part, in close contact and parallel with each other, and there is no apparent twist in their course. Their axial canals are but rarely preserved, and the natural termination of the spicules is unknown. They are nearly circular in transverse section, and vary from ·15 to ·7 mm. in thickness. The surface of some of these spicular rods is quite smooth, whilst in others there is a minute projecting frill, disposed in an annular or spiral form, so that the spicule appears to be covered with transverse, slightly wrinkled striæ. The spicular rods also occur detached and scattered through the rock, crossing each other in various directions.

This species was founded by Prof. M'Coy on a fragmentary band of spicules embedded in dark limestone of Llandeilo age. Special mention is made in the description of the irregular transverse plicæ on the surface of the spicules, or tubes, as they are termed; and this structure is clearly shown in the accompanying figure pl. i B, fig. 13 *a*. In the original specimen, however, now preserved in the Woodwardian Museum, Cambridge, the "plicæ" are very indistinct, and they can scarcely be distinguished from fractures in the spicules. In other specimens from Llandeilo rocks, the transverse frills are very prominent, and they form one of the distinguishing characters of the species. In some bundles, nearly all the spicules are frilled, but in others, only one in ten, or one in twenty are thus ornamented, whilst the others are quite smooth. In the anchoring rope of the recent *Hyalonema*, Gray, some of the spicules are likewise furnished with spiral frills,[1] bearing minute spines, thus showing a general correspondence in structure to these Cambrian forms.

Slight differences exist in the maximum thickness of the spicular rods in different bundles; for, whilst in some the largest spicules do not exceed ·5 mm. in

[1] Carter, 'Ann. and Mag. Nat. Hist.,' ser. 4, vol. xii (1873), p. 372, pl. xiv.

thickness, in others they reach to ·7 mm. In every instance smaller spicules are intermingled in the same bundles with the larger. In all the specimens examined the spicules are composed of chalcedonic silica.

The larger bundles, which are not infrequent in the Llandeilo strata of Pont Ladies, are usually curved and folded over in various ways, which appear to result from the compressing and folding of the rocks in which they are enclosed.

M'Coy correctly compared this species with the anchoring rope of the recent *Hyalonema*, which at that time was regarded as a zoophyte, and it is placed in Morris's catalogue with the Gorgonidæ. The specimen discovered by Dr. Hicks in the Tremadoc strata of St. David's, was originally described by him as a vascular cryptogam under the name of *Eophyton ? explanatum ;* its true nature appears to have been first noticed by Dr. Nathorst, who pointed out its similarity to M'Coy's species.

In the size of the spicules forming the bundles the present species corresponds very closely with *Hyalostelia parallela*, M'Coy sp., from the Carboniferous strata of Ireland, but transverse striæ are not developed in any of the spicules of this latter form.

Distribution.—Cambrian : Tremadoc strata, St. David's (Dr. Hicks). Ordovician : Llandeilo, Tre Gil, south of Llandeilo (M'Coy) ; Meadowtown, Pont Ladies, Mincop, Shelve, Shropshire (Mr. G. H. Morton); near Builth ? (Wyatt-Edgell Coll. in Geol. Surv. Museum) ; Dobb's Linn, Moffat (Prof. Dr. H. A. Nicholson).

ORDOVICIAN SPONGES.

Sub-Order.—Lithistidæ.

Family.—Anomocladina.

Genus.—Astylospongia, *F. Roemer.*

1860. Die silurische Fauna des westlichen Tennessee, p. 5.

Syn.—Siphonia, in part *Goldfuss ; Hisinger.*

Generic Characters.—Sponges sub-spherical or ovate in form, simple, free, with rounded bases, in which there is no indication of any surface of attachment. Two systems of canals are present, one extending from the outer surface towards the centre of the Sponge, and the other of large canals which have a generally vertical direction, following the outlines of the Sponge, and opening either into a shallow

cloacal depression or freely at the summit. The spicular structure is a firm resistant mesh-work composed of spicules with solid rounded nodes or centres, from which from six to nine straight arms radiate in different directions. The spicular rays terminate in branched and slightly expanded processes, which are closely apposed to the nodes of adjoining spicules to form the skeletal meshwork; in some cases, also, the rays meet where no centres exist, and their extremities partially interlock together and form a pseudo-node by their union.

The Sponges of this genus were originally regarded as belonging to the genus *Siphonia*,[1] and as having been derived from Cretaceous strata. A similarity in their canal-structures to those of true *Siphoniæ* supported this belief, and their actual occurrence in the Drift deposits of Northern Germany mingled with Chalk Sponges was accepted as a confirmation of their coexistence in the Cretaceous strata. The subsequent discovery by F. Roemer[2] of the same forms in unquestionably Silurian strata in North America led to a recognition of their true position. They were then placed, both by Zittel[3] and by Roemer, with the Hexactinellidæ,[4] from the supposed six-rayed character of the spicules; but after that Dr. R. Martin[5] had pointed out the variable number of the rays in the spicules, Zittel[6] removed the genus to the Anomocladina family of the Lithistidæ, to which it is naturally allied both in general form, in its canal-systems and its spicular structure. Zittel, however, now regards the elementary spicules of the genus as simple rods with branching extremities, which by their union together form the nodes. There is some difficulty in determining the character of the elementary spicules, since in no instance at present have they been found detached, whilst in the connected skeletal mesh the union is so intimate that their elementary characters are concealed. In the recent[7] *Vetulina stalactites*, Os. Schmidt, which has been placed by Zittel in the same family as *Astylospongia*, the elementary spicules clearly consist of rays projecting from central nodes, and there is reason to conclude that the spicular elements of *Astylospongia* were similarly constituted.

The species of this genus are limited to Ordovician and Silurian strata, principally the latter. They are comparatively abundant in North America and in the Silurian districts of the Baltic, but with the single exception of the form mentioned below from Caradoc strata, the genus is not otherwise represented in this country.

1 'Petref. Germ.,' vol. i, p. 17.

2 'Die silurische Fauna d. westl. Tenn.,' p. 5.

3 'Studien I,' p. 44.

4 'Lethæa pal.,' p. 307.

5 "Untersuchung über die Organisation von *Astylospongia*," 'Archiv des Ver. d. Freunde d. Naturgesch. in Mecklenburg,' Jahrg., xxxi, 1877.

6 "Ueber Astylospongidæ und Anomocladina," 'Neues Jahrb.,' 1884, Bd. ii, p. 75.

7 See Sollas, "On *Vetulina stalactites*" (O. S.), 'Proc. Roy. Irish Acad.,' 2 ser., vol. iv, p. 486.

4. Astylospongia inciso-lobata, *F. Roemer.* Plate II, figs. 5, 5 *a.*

1860.	Astylospongia	inciso-lobata,	*F. Roemer.*	Die silur. Fauna d. westl. Tenn., p. 11, pl. i, figs. 3, 3*a.*
1848.	Spongia	—	—	Leonh. u. Bronn's Jahrb., p. 685.
1861.	Astylospongia	—	—	Die fossile Fauna von Sadewitz, p. 13, pl. ii, fig. 4.
1864.	—	—	*Salter.*	Quart. Journ. Geol. Soc., vol. xx, p. 239, Note.
1873.	—	grata,	— M.S.	Cat. Cambrian and Silur. Foss. Cambridge, p. 31.
1880.	—	inciso-lobata,	*F. Roemer.*	Lethæa pal., p. 310.

Sponges depressed spherical in form, with shallow furrows extending down the sides so as to form imperfect lobes. The canals open freely at the summit of the Sponge.

The only British example of this species, now preserved in the Museum of the Geological Survey, Jermyn Street, is 16 mm. in height by 36 mm. in transverse diameter. The summit is slightly convex, and the canal-apertures, about 1 mm. in width, are irregularly disposed over it. Six shallow furrows, indicating as many lobes, extend from near the summit to the base. The interior of the specimen is now a solid mass of iron-pyrites, in which only traces of canals can be distinguished, and, as the spicular structure is altogether obliterated, its true character is not altogether free from doubt. The specimen was originally referred to *A. inciso-lobata* by Mr. Salter, but subsequently, in the catalogue of the Cambrian and Silurian fossils at Cambridge, he named it *A. grata*, MS., without, however, adding any description. As from the condition of the specimen no other feature beyond the outer form is available for comparison, it seems preferable to place it in the present species, which is distinguished by similar lobate outlines.

Distribution.—Ordovician: Caradoc Shale, Haverford-west, South Wales. It also occurs in Silurian strata in West Tennessee, and in Glacial Drift at Sadewitz, Lower Silesia (F. Roemer.)

Genus.—Hindia, *Duncan.*

1879. Ann. and Mag. Nat. Hist., ser. 5, vol. iv, p. 84.

Syn.—Calamopora, *F. Roemer* (non Goldfuss), *Steinmann;* Sphærolites, *Hinde.*

Sponges spherical or sub-spherical in form, free, without stem or any surface of attachment. The body of the Sponge is traversed throughout by straight, simple, subcylindrical or prismatic, sub-equal canals, radiating, in close proximity to each other, from a central space, and opening freely at the surface. The skeleton consists of spicules generally with four rays (though occasionally only three are developed) which extend from a compressed central node. Three of the rays are sub-equal, whilst the fourth is truncated. The rays terminate in flattened, circular, irregularly digitate expansions, which firmly clasp the nodes and convex surfaces of the rays of adjoining spicules in such a manner as to form an extremely regular meshwork, with transversely elliptical interspaces.

Specimens of this genus from West Tennessee were originally described as corals by F. Roemer[1] under the name of *Calamopora fibrosa.* They occur as silicified casts, in which the original structure has been entirely removed; and in this condition they resemble very closely small silicified corals. Without being aware of F. Roemer's reference of the forms to corals, I made a similar mistake respecting forms which I had collected from New Brunswick, erroneously regarding them as perforate corals, which I named *Sphærolites.*[2] My specimens were afterwards submitted to Prof. M. Duncan,[3] who recognised the spicular nature of this skeleton, and constituted them into a new genus of Sponges, which he named *Hindia.* The original silica in these specimens had been replaced by calcite, but Prof. Duncan, maintaining that the skeletons were originally of calcite, principally on the ground of the supposed presence in them of a parasitic Alga, regards the forms as Calcisponges, representing a former mimetic and calcareous group of Spongida. Their general structure corresponds so closely with that of Lithistid Sponges that I felt justified in placing the genus in the Anomocladina family of this group;[4] Zittel,[5] however, regarded the genus as more properly coming within the Megamorina family. A later writer,[6] Dr. Steinmann, has asserted that the genus exhibits none of the characters of Lithistid Sponges, and that it really

[1] 'Die silur. Fauna d. westl. Tenn.,' p. 20.
[2] 'Abstract Proceedings Geol. Soc.,' 1875, No. 305.
[3] 'Ann. and Mag. Nat. Hist.,' ser. 5, vol. iv, p. 84, 1879.
[4] 'Cat. Brit. Foss. Spong.,' p. 57, 1883.
[5] 'Neues Jahrb.,' 1884, Bd. ii, p. 79.
[6] Ibid., 1886, Bd. i, Heft i, p. 91.

belongs to perforate corals like *Favosites.* In reply to this, Dr. H. Rauff[1] showed more clearly than had been done by previous writers the spicular characters and the structure of the genus, which, however, he placed in the Tetracladina family of Lithistids. Prof. Duncan,[2] still relying on the supposed parasitic borings in the Sponge, has reasserted that it was an originally calcareous organism. Whatever may be the nature of the bodies which Prof. Duncan refers to Algæ, it is evident, from the fact that they are present in the siliceous matrix of the Sponge, and apparently do not penetrate the spicules themselves, that they have no bearing on the original mineral constitution of the Sponge itself. The specimens, in which the skeleton is now of carbonate of lime, present the same evidence that this mineral is a replacement of silica, as the calcified examples of *Astylospongia* and other Lithistid Sponges from the Silurian strata, and there is but little doubt that as in these forms the original spicular structure of *Hindia* was siliceous.

The character of the spicules, consisting of a central node with diverging rays, and their mode of union to form the skeleton by the clasping of their expanded extremities to the nodes of adjoining spicules, appear to me to indicate their position in the Anomocladina family.

Hindia makes its first appearance in Ordovician strata in Ayrshire and in Illinois; it is more abundant in Silurian strata in various places in North America, Russia, Isle of Gothland, Sweden, and in the Drift deposits of Northern Germany. Detached spicules, referable to the genus, are also present in the Carboniferous Limestone of Sligo, Ireland, and the Yoredale Beds of Yorkshire.

5. HINDIA FIBROSA, *F. Roemer* sp. Plate IX, figs. 3, 3 *a*—3 *e*.

1860. CALAMOPORA FIBROSA, *F. Roemer* (non *Goldfuss*). Die silur. Fauna d. westl. Tenn., p. 20, pl. ii, figs. 2, 2 *a*, *b*.
1861. MONTICULIPORA PETROPOLITANA (in part), *F. Roemer.* Die fossile Fauna von Sadewitz, p. 28.
1863. ASTYLOSPONGIA INORNATA, *Hall.* Sixteenth Annual Report State Cabinet Nat. Hist., p. 69.
1875. SPHÆROLITES NICHOLSONI, *Hinde.* Abstract Proc. Geol. Soc., No. 305.
1879. HINDIA SPHÆROIDALIS, *Duncan.* Ann. and Mag. Nat. Hist., ser. 5, vol. iv, p. 84, pl. ix.
1883. — FIBROSA, *Hinde.* Cat. Foss. Sponges, p. 57, pl. xiii, figs. 1, 1 *a*, 1 *b*.
1884-5. — — *F. Roemer.* Lethæa erratica. Palæontolog. Abhandl., 2te Bd., Heft 5, p. 310, pl. xxvii, fig. 17.

[1] 'Sitzungsber. der niederrhein. Gesellsch. zu Bonn,' 1886.
[2] 'Ann. and Mag. Nat. Hist.,' vol. xxiii (1886), p. 226.

1886.	CALAMOPORA FIBROSA, *Steinmann.*		Neues Jahrb., Bd. i, Heft 1, p. 91.
1886.	HINDIA	— *Rauff.*	Sitzungsber. der niederrhein. Gesellsch. zu Bonn, p. i, sep. copy; also in Ann. and Mag. Nat. Hist., ser. 5, vol. xviii, p. 169.
1886.	—	SPHÆROIDALIS, *Duncan.*	Ann. and Mag. Nat. Hist., ser. 5, vol. xviii, p. 226.
1887.	—	FIBROSA, *Hinde.*	Ann. and Mag. Nat. Hist., ser. 5, vol. xix, p. 67.
1887.	—	SPHÆROIDALIS, *Duncan.*	Ann. and Mag. Nat. Hist., ser. 5, vol. xix, p. 260.

The Sponges vary in form from nearly perfect spheres to biconvex discs, the outer surface is usually smooth and even. They range from 13 to 45 mm. in diameter.

In the centre of the Sponge is a small round space filled by irregular spicular tissue; from the outer border of this the canals radiate to the surface. The canals vary from ·18 to ·45 mm. in width, the smaller irregularly intermingled with the larger; their apertures are for the most part oval or elliptical. The wall between the canals consists of only a single layer of spicular tissue.

In most, if not in all cases, four rays are developed in the spicules. The central node is compressed, somewhat triangular in form, and slightly curved rays are given off from each corner (Pl. IX, figs. 3 *c*, *d*, *e*). The concave surface of the rays is smooth and even, whilst the convex is dentate or covered with tubercles. Their terminations are frequently considerably expanded, transversely to the ray itself. The fourth ray projects upwards from the centre of the node. It is usually only a short stumpy process terminating in from two to four conical spurs. The spicules are so disposed in the skeleton that the fourth ray points to the surface of the Sponge, whilst each of the other three rays is closely apposed to the nodes and convex surfaces of as many different spicules. Each spicule, therefore, supports on its upper surface three rays converging to it from adjoining spicules. The junction of these rays conceals to a large extent the shortened fourth ray, so that as a rule only its terminal spurs can be seen. The spicular rays are about ·16 mm. in length, and ·05 mm. in thickness. No canals have been discovered in them.

The union of the spicules forms a closely reticulated skeleton with generally elliptical apertures, about ·12 mm. in width, which appear as so many perforations in the walls of the radial canals.

The only example of this species from British strata is a small, irregularly-shaped, nodular fragment, discovered by Prof. H. Alleyne Nicholson, in limestones of Ordovician age at Girvan, Ayrshire. The specimen appears to be incomplete, so that its entire figure is uncertain, and the spicular structure has been so completely replaced by crystalline calcite, that the individual form and the union of the

spicules cannot be recognised. Longitudinal and transverse sections, however, clearly show its affinities with the genus, and so far as can be ascertained from the condition of the specimen it belongs to the present species.

Distribution.—Ordovician: Girvan, Ayrshire (Prof. H. A. Nicholson); Trenton limestones, near Chicago (Dr. W. R. Head). Silurian: Wänge, Isle of Gothland (Prof. G. Lindström); St. Petersburg, Russia; Perry County, Tennessee (F. Roemer); Lower Helderberg Group, Dalhousie, New Brunswick; Scoharie, New York. Glacial drift: Sadewitz, Lower Silesia (F. Roemer); Lyck, East Prussia; Rombitten, West Prussia (F. Roemer); Island of Sylt, Holstein (Haas).

6. Hyalostelia Smithii, *Young and Young* sp. Plate I, figs. 4, 4 *a*.

1877. Hyalonema Smithii, *Young and Young* (in part). Ann. and Mag. Nat. Hist., vol. xx, p. 426, pl. xiv, figs. 1—3, 5—12, 14—17.
1880. — ? Girvanense, *Nicholson and Etheridge, junr.* Mon. Silur. Foss. Girvan, Fasc. ii, p. 239, pl. xix, figs. 1—1 *b*.

The references to this species and its characters will be more fully given in treating of the Carboniferous Sponges; it is introduced here to include a specimen of elongated spicular rods from Ordovician strata.

The spicular rods in the only specimen known from this horizon are not united in bundles, but they are detached and distributed irregularly at short distances from each other in the rocky matrix. They are circular in transverse section, with apparently smooth surfaces. Their length and natural terminations are unknown. They vary very considerably in thickness, the slender rods not exceeding ·15 mm. in diameter, whilst the stoutest spicules are 1·4 mm. The axial canals are occasionally preserved.

These spicules were referred by Messrs. Nicholson and Etheridge to a distinct species, principally on account of peculiar transverse bands of varying thickness, which occur at intervals in the spicules and were believed to indicate a distinct structural feature. In sections of the type specimen from which the figures on Plate I are drawn, the spicules exhibit, by polarized light, the optical characters of chalcedonic and crystalline silica, but in the banded intervals the silica has evidently been replaced by some other mineral. The replacement has been effected along minute transverse fissures in the spicules, and the same mineral has likewise been deposited in places on their outer surfaces. It seems clear, therefore, that the bands are not original, but merely secondary structures resulting from fossilization.

In their relative proportions these spicular rods agree with those forming the

anchoring-rods of *H. Smithii*, and in the absence of any other distinguishing characters they may be included in this species. The larger spicules considerably exceed in size those in *H. fasciculus*, M'Coy sp. The only examples of this species are in the cabinet of Professor C. Lapworth, F.G.S.; the microscopic section from them, which has been figured, is in the possession of the author.

Distribution.—Ordovician. In a light grey limestone at Knockgeiran, near Girvan, Ayrshire.

Family.—RECEPTACULITIDÆ.

Genus.—ISCHADITES, *Murchison.*

1839. Silurian System, p. 697.

Syn.—Tetragonis, *Eichwald*, *Gümbel* (in part), *F. Roemer* (in part), *and other authors.* Receptaculites, *Eichwald* (in part), *Schmidt*, *Billings* (in part), *Meek*, *Worthen*, *Hall*, *Whitfield*, *and others.* Selenoides, *D. D. Owen.*

Sponges conical, ovate, subspherical, or pyriform, with conical, sometimes slightly elevated summits, in which there is a circular perforation opening into a central cavity. The distal or summit ray of the hexactinellid spicules forming the skeleton is modified into a delicate rhomboidal plate, which rests upon the four transverse or horizontal rays, whilst the ray extending inwards at right angles to the surface gradually tapers to an acute point. The spicules are disposed so that the summit plates are nearly in contact, and form regular spiral curves, extending from the basal nucleus to the summit of the Sponge, thus presenting an appearance like the engine-turned case of a watch (Plate II, fig. 2 *a*). The transverse horizontal spicular rays overlap each other, but are not united together, and they divide the surface of the Sponge beneath the summit plates into oblong areas. (Plate II, figs. 1, 1 *a*).

Ischadites is distinguished from *Receptaculites*, Defrance, and *Acanthochonia*, Hinde, by its conical or ovate form enclosing a central cavity, and from *Sphærospongia*, Pengelly, by the rhomboidal form of its spicular plates.

In common with the allied genera of this family, *Ischadites* has till lately been placed with the Foraminifera, though by Billings and subsequently by Salter it was regarded as a Sponge.

I have[1] already given in some detail the arguments in favour of the spicular structure, and therefore Sponge-nature of this genus and its allies, which appear

[1] 'Quart. Journ. Geol. Soc.,' vol. xl, p. 827.

to me sufficient to justify placing them with Sponges notwithstanding the abnormal character of the spicules and their peculiar arrangement in the skeleton.

Ischadites makes its first appearance in Ordovician strata (Llandeilo), and continues through the Silurian, but has not been recognised above this horizon. It occurs in Wales and the West of England, Scotland, Norway, Isle of Gothland, Sweden, Baltic Provinces of Russia, and in the United States and Canada.

7. Ischadites Kœnigii, *Murchison*. Plate II, figs. 1, 1 *a*, 1 *b*.

1839. Ischadites Kœnigii, *Murchison*. Silurian System, p. 697, pl. xxvi, fig. 11.
1837. Polyparium — *Hisinger*. Lethæa Suecica, p. 115, pl. xxxvi, Supplement, fig. 2.
1842. Receptaculites Bronnii, *Eichwald*. Urwelt Russlands, Heft 2, p. 80, pl. i, fig. 9.
1852. Selenoides iowensis, *D. Dale Owen*. Geol. Surv. Wisconsin, &c., p. 587, pl. ii b, fig. 13.
1854. Receptaculites Neptuni, *Morris*. Cat. Brit. Foss., 2nd edit., p. 363.
1858. — Eichwaldi, *Schmidt*. Die Silur. Formation von Ehstland, &c., p. 232.
1860. — Bronnii, *Eichwald*. Lethæa rossica, vol. i, p. 429, pl. xxvii, figs. 2 *a*, *b*.
1860. Ischadites Eichwaldi, *Eichwald*. Lethæa rossica, vol. i, p. 436, pl. xxvii, figs. 3 *a*, *b*, *c*.
1865. Receptaculites Jonesi, *Billings*. Pal. Foss. Canada, vol. i, p. 385, fig. 363; p. 389, fig. 365.
1865. — iowensis, *Billings*. Ibid., p. 385, fig. 364.
1866. Ischadites antiquus, *Salter*. Mem. Geol. Surv. Gt. Brit., vol. iii, p. 282, fig. 4.
1867. — tessellatus, *Salter*, MS. (See Siluria, 4th ed., p. 509.)
1868. Receptaculites globularis, *Meek and Worthen*. Geol. Surv. Illinois, vol. iii, p. 301, pl. ii, figs. 2 *a*, *b*.
1868. — sp.? — — Ibid., p. 301, pl. ii, figs. 1 *a*, *b*.
1873. Ischadites Kœnigii, *Salter*. Cat. Cambrian and Silur. Foss. Cambridge, p. 100.
1875. Receptaculites Ohioensis, *Hall and Whitfield*. Geol. Surv. Ohio, Pal., vol. ii, p. 123, pl. vi, fig. 1.
1875. — subturbinatus, *Hall*. Twenty-Seventh Annual Report State Museum, Albany, pl. iii, figs. 1, 2, 3.

1875.	Ischadites Kœnigii, *Gümbel.*	Beiträge Abhandl. k. bayer. Akad. Wiss., Bd. xii, Abtheil. i, p. 43, pl. A, figs. 28, 29, 30.
1878.	— — *Nicholson and Etheridge, jun.*	Silur. Foss. Girvan, p. 20.
1878.	— — *Quenstedt.*	Petref. Deutschl., vol. v, p. 592.
1880.	— — *Zittel.*	Handb. der Pal., vol. i, p. 728.
1880.	— — *F. Roemer.*	Lethæa Pal., p. 291.
1882.	— — *Rupert Jones.*	Cat. Foss. Foram. Brit. Mus., p. 2.
1884.	— — *Hinde.*	Quart. Journ. Geol. Soc., vol. xl, p. 836, pl. xxxvi, figs. 1, 1 *a*—*o*.

Sponges depressed-conical, or ovate in form, with convex, flattened, or rarely concave bases, which are quite smooth, and do not show any indications of a stem or surface of attachment. The summits are generally truncate or evenly rounded, occasionally with a slightly-elevated neck; the central aperture is from 2 to 5 mm. in width. Small individuals are only 4 mm. in height by 6·5 mm. in greatest width, whilst large forms are 40 mm. by 45 mm.

At the basal nucleus or commencement of growth there are eight minute spicules, with diamond-shaped summit-plates, disposed in a stellate form; the spicules succeeding these gradually increase in size to the zonal region of the Sponge, and then gradually diminish again towards the summit. The spicular summit-plates in the zonal areas vary in different specimens from 2 to 4 mm. in width, whilst near the top of the Sponge surrounding the aperture they are only from ·25 to ·4 mm. wide. The four horizontal or transverse rays of the spicules as a rule slightly exceed in length the semi-diameter of the respective summit-plates, and thus overlap each other. In some cases the transverse ray, which points towards the top of the Sponge, extends beyond the summit-plate, and projects partly over the plate of the spicule next above it. The spicular rays extending inwardly towards the centre of the Sponge vary from 7 to 10 mm. in length.

The examples of this species vary considerably in size and in details of outer form, but in a large series of specimens numerous transitional forms are present, connecting the extreme variations, thus showing the untenability of the species which by different authors have been founded on these individual differences.

The specimens from British strata are so altered by fossilization, that it would be impossible from them alone to understand the original structures. Even their outer forms have been considerably compressed and distorted so as to appear as merely flattened plates or thin discs, or even as surface impressions only. The summit aperture is usually concealed, and the base of the Sponge is scarcely distinguishable from the top. The spicular structures are now only represented by negative casts in the rock-matrix. Generally the surface of these specimens is

marked out by delicate curved ridges, which cross each other with great regularity, and thus form rhomboidal, slightly depressed areas, which represent the spaces occupied by the summit-plates of the spicules. Within each of these areas the cross formed by the four transverse rays can be distinguished (Pl. II, fig. 1 *b*), and occasionally at the centre of this a small circular aperture indicates the entering ray of the spicules. In other conditions of preservation the rhomboidal areas are not shown, and the surface of the specimen exhibits only the vertical and concentric lines formed by the transverse spicular rays (Pl. II, fig. 1 *a*).

Mr. Salter[1] has figured this species with a short stem and diverging rootlets, and he has stated that specimens possessing these appendages occur at Llangollen. I have not met with any example in the museums at Cambridge or at Jermyn Street showing the least indications of these structures, and it is evident from their absence in the remarkable perfect specimens from the Isle of Gothland, which were kindly lent to me by Prof. G. Lindström, of Stockholm, that Mr. Salter's figures are purely diagrammatic.

The type of this species, and of the genus as well, is preserved in the museum of the Geological Society, Burlington House. It shows the casts of several individuals on a slab of hard, bluish, calcareous shale. In common with other members of this family, considerable numbers of these Sponges appear to have generally lived in close association with each other. The types of *Ischadites antiquus*, Salter, and *I. tessellatus*, Salter, both in the Museum of the Geological Survey, Jermyn Street, do not appear to me to be separable from *I. Kœnigii*.

Distribution.—Ordovician: Lower Llandeilo; Garn, Arenig Mountain, Wales. Caradoc; also in Galena Beds; at Seale's Mound, Illinois, and in Iowa. Orthoceras Limestone; Reval, Esthonia. Silurian: Woolhope Beds; Malvern; near Buildwas, Shropshire. Wenlock shales and limestones; Dudley, Usk, Malvern, Walsall, Balcletchie, Penkill, Ayrshire. Lower and Upper Ludlow; Ledbury, and near Ludlow; Pentland Hills, Scotland; Visby, Westergarn, near Klintehamn, Djupvik, Isle of Gothland; Niagara Group; Waldron, Indiana; Yellow Springs, Ohio; Lower Helderberg Group; Gaspé, Province Quebec.

[1] 'Cat. Cambrian and Silur. Foss. Cambridge,' p. 100.

SILURIAN SPONGES.

Sub order.—MONACTINELLIDÆ.

Genus.—ATRACTOSELLA,[1] *Hinde*, gen. nov.

The form of the Sponge is unknown, the genus is proposed to include detached spindle-shaped spicules, with blunted extremities. In some spicules the central portion is thickest, and they gradually and evenly taper to both ends, but more frequently the greatest thickness is nearer one end of the spicule than the other, and thus it tapers abruptly to one extremity and gradually to the other.

8. ATRACTOSELLA SILURIENSIS, *Hinde*, sp. nov. Plate I, figs. 6, 6 *a*—6 *d*.

The spicules are circular in transverse section; they vary from ·82 mm. to 1·62 mm. in length, and from ·12 to ·25 in thickness; judging from broken fragments, even larger forms are also present. Their surfaces are smooth and even. The spicules retain their siliceous structure, and in some the axial canal is shown. As the spicules are entirely detached from each other, there are no means of determining the nature of the Sponge to which they belong, but provisionally they may be referred to the Monactinellidæ. Spicules of this order are very rare at this horizon, and no others have as yet been met with in this country. The forms figured were discovered by Mr. John Smith, of Kilwinning, in decayed limestones.

Distribution.—Silurian: Wenlock Beds, near Craven Arms, Shropshire.

Sub-order.—HEXACTINELLIDÆ.

Family.—PROTOSPONGIDÆ.

Genus.—PLECTODERMA, *Hinde.*

1883. Catalogue Fossil Sponges Brit. Mus., p. 132.

Generic Characters.—Entire form of Sponge unknown; the wall consists of a thin spicular meshwork composed of cruciform and five-rayed spicules, and possibly

[1] ἄτρακτος, a spindle, dimin.

also of linear spicules, which are grouped together, so that the spicular rays which extend the length of Sponge form, by their apposition and overlapping each other, continuous spicular fascicules, whilst the transverse rays extend singly on either side of the vertical rows, and overlap those from the adjoining rows, so as to produce an irregular framework. Smaller spicules are irregularly interspersed in the intervals between the larger.

This genus is closely related to *Protospongia*, Salter, and *Dictyophyton*, Hall; but the arrangement of its spicular mesh is far less regular than in either of these genera, and there are no definite quadrate areas. From *Protospongia* it is further distinguished by the fascicular grouping of the spicular rays in a vertical direction.

9. Plectoderma scitulum, *Hinde*. Plate III, figs. 1, 1 *a*, 1 *b*.

1883. Plectoderma scitulum, *Hinde*. Cat. Foss. Spong., p. 132, pl. xxxi, figs. 1 1 *a*, 1 *b*.

The fragment of the Sponge-wall which has been preserved is about 60 mm. in width and 45 mm. in height; it probably formed part of a cup- or funnel-shaped sponge. The vertical fascicles are about 7·5 mm. apart from each other; there are from five to ten spicular rays in close juxtaposition in each fascicle, but from their present condition it cannot be determined whether they were laterally cemented together or not. The spicules vary greatly in size; the rays of the slender forms are not more than ·09 mm. in thickness, whilst in some of the larger forms the rays are ·35 mm. in thickness, and 6·5 mm. in length. The rays are straight, curved, or occasionally wavy, they usually taper very gradually from the central node to their extremities. Traces of smaller spicules can be occasionally seen in the interspaces between the larger, and it is probable that they formed part of a continuous spicular membrane extending between the framework formed by the larger spicules.

The type-specimen, the only one hitherto discovered, is preserved on the surface of a soft, micaceous, shaly rock. The spicules are now mostly represented by empty casts, but in some cases fragments of the original siliceous spicules, still retaining their axial canals, are preserved. The wall at first sight appears to consist of rod-like spicules, crossing each other at right angles, but where the spicules are less thickly grouped together the four rays of a spicule springing from a centre can be distinctly seen, and at the common centre there is often a small circular aperture, indicating a fifth ray extending inwards at a right angle to the

other four in the plane of the wall. It is very likely that rod-like spicules may also be intermingled with the cruciform and five-rayed spicules.

The type-specimen is in the collection of the Geological Survey of Scotland, Edinburgh.

Distribution.—Silurian: Upper-Ludlow strata; Wetherlawlinn, Pentland Hills, near Edinburgh.

Genus.[1]—PHORMOSELLA, *Hinde*, gen. nov.

Generic Characters.—Spherical or sacciform Sponges, apparently free. The skeleton consists of a delicate wall of spicular tissue, composed of cruciform spicules, so disposed that their rays mark out sub-quadrate areas, which are filled in with smaller spicules so as to form a connected meshwork.

This genus is proposed to include some small Sponges which are preserved as compressed oval markings on the surface of a slab of arenaceous rock. Only the impressions of the spicules in iron-peroxide are shown; their arrangement differs from that in the allied genus *Protospongia*, in that there is only a single series of squares in which the smaller spicules are somewhat irregularly disposed. The larger spicules are not grouped in bundles as in the vertical series of *Plectoderma* and in *Dictyophyton*, but they are disposed singly, so that their rays overlap and form vertical and transverse lines.

10. PHORMOSELLA OVATA, *Hinde*, sp. nov. Plate III, figs. 2, 2 *a*, 2 *b*.

The Sponges are circular or oval in outline, without trace of a stem or point of attachment. They vary from 12 to 17 mm. in diameter. No summit-aperture is perceptible, since all the specimens appear to have been compressed laterally so that they are now mere films on the rock-surface. The rays of the larger cruciform spicules, which mark the sides of the squares, are from 2 to 3 mm. in length. The spicular axes, though generally longitudinal and transverse with respect to the Sponge, sometimes diverge slightly, so that the vertical and horizontal lines are not always strictly continuous. The smaller spicules of the skeleton are very indistinctly seen; they do not exhibit any regular arrangement. In some specimens there are minute punctate elevations and depressions, probably indicating a fifth ray in some of the spicules.

[1] φορμός, anything plaited, dimin.

The only form with which the present species can be compared is that described by the late Dr. Holl[1] under the name of *Protospongia maculæformis.* Judging from the short description, unaccompanied by a figure, this form, which occurs under similar conditions of preservation, belongs to the genus *Phormosella.* It is about as large again as *P. ovata.* Unfortunately the type specimen has been lost, and no other is known.

Phormosella ovata is of rare occurrence, but judging from the number of individuals associated together on the same slab as represented by fig. 2, it appears to have been of a gregarious habit. The type specimen is in the Museum of the Geological Survey, Jermyn Street.

Distribution.—Silurian: Aymestry Rock, Mocktree, Shropshire.

Genus.—Dictyophyton, *Hall.*

1863. Sixteenth Annual Report State Cabinet, New York, p. 87.

Syn.—Hydnoceras, *Conrad;* Tetragonis, *M'Coy*, *Salter*, *F. Roemer* (in part).

Generic Characters.—Cylindrical, prismatic, or cup- or vase-shaped Sponges, probably free, since neither stem nor anchoring appendages have been discovered.

The walls consist of a connected spicular framework disposed so as to form rectangular, quadrate, or oblong areas, which may be subequal or of larger and subordinate squares. The character of the spicules of the framework is not fully known, they appear to be arranged in bundles, but whether these bundles are composed of cruciform, or merely rod-like, spicules has not yet been determined. A thin membrane appears to have extended over the area between the framework. The mode of union of the spicules is not definitely known.

The type of the genus was regarded by Conrad[2] as representing a sub-genus of *Orthoceras*, which he named *Hydnoceras tuberosum.* Subsequently Prof. James Hall believed it to be the frond of a marine alga, and with Conrad's consent changed the generic name to *Dictyophyton.* In 1879 the late Prof. Schimper[3] expressed doubts as to its plant nature, and stated that its structure much nearer resembled the skeleton of siliceous Sponges. Later, Ferd. Roemer[4] pointed out the similarity of its structure to that of *Tetragonis Danbyi*, M'Coy. After this, Mr. R. P. Whitfield[5] compared this genus, with other allied forms, to Sponges like the

[1] 'Geol. Mag.,' vol. ix (1872), p. 350.

[2] 'Journ. Nat. Sci. Phil.,' vol. viii, p. 267.

[3] 'Zittel and Schimper's 'Handb. der Pal.,' Bd. ii, Lief. 1, p. 69.

[4] 'Lethæa pal.,' Th. i, p. 127.

[5] 'Amer. Journ. of Science,' vol. xxii, p. 53.

recent *Euplectella*, and its Sponge character has been generally accepted by later authors, including Prof. Hall,[1] who has placed it with several other genera in a separate family of fossil reticulate Sponges; but the structural features of these genera are not stated with sufficient clearness for an opinion to be formed as to their value, and the characters assigned to the family are equally indefinite.

As a general rule, the examples of this genus only occur in the form of casts, in which the structure of the Sponge-wall is represented either by depressed or raised longitudinal and transverse lines, forming regular squares in an arenaceous matrix, and a thin film extends over the areas between the lines. Some of the raised lines are stronger than others, and mark out larger squares, within which subordinate squares are indicated by lighter impressed lines. Both the longitudinal and transverse lines are continuous, and the extreme regularity of their course seems to indicate that their component spicules must have been firmly united together. In these casts the wall of the Sponge appears to consist of but a single layer of spicular tissue.

Mr. R. P. Whitfield[2] has stated that the longitudinal and transverse fibres in *Dictyophyton cylindricum* are composed of bundles of cylindrical spicules of various sizes and of great length, but no mention is made of the presence of cruciform spicules. Prof. Hall[3] also states that "the structure of the frond which characterises every member of this family may be described as a reticulation of tubular spicules forming rectangular meshes;" but here again nothing is said of the form of the spicules. This author also refers to three spicular layers in the wall—a middle layer, which is uniformly reticulate, and inner and superficial layers, which show an oblique and sometimes a radiate arrangement of spicules; but these are not shown in any example of *Dictyophyton* which he has figured.

Assuming that the lines shown in the casts of *Dictyophyton* are really composed of fascicles of spicules, this genus is distinguished from *Protospongia*, Salter, by the fact that the quadrate areas of the wall in this latter form consist only of individual spicules. It differs likewise from *Plectoderma*, Hinde, in the regular arrangement of the surface squares and in having the transverse lines of the wall of spicular fascicles, instead of individual forms.

The earliest appearance of *Dictyophyton* is in the Upper-Ludlow strata of this country, it also occurs in the Middle Devonian of the Eifel, Germany, and New York, and attains its greatest development in the Upper Devonian (Chemung Group) of North America, and it is also present in the same formation (Psammites du Condroz) in the Ardennes (Barrois). It makes its last appearance in the Lower Carboniferous of Ohio and Indiana.

[1] 'Thirty-fifth Annual Report New York State Museum' (1884), p. 465.

[2] 'Bulletin No. 1, Amer. Mus. Nat. Hist.,' December, 1881, p. 19.

[3] 'Thirty-fifth Annual Report on the New York State Museum,' p. 465.

11. Dictyophyton Danbyi, *M'Coy*, sp. Plate II, figs. 4, 4 *a*, 4 *b*, 4 *c*.

1852.	Tetragonis Danbyi,	*M'Coy.*	Brit. Pal. Foss., p. 62, pl. i d, figs. 7, 8.
1854.	— —	*Morris.*	Cat. Brit. Foss., p. 90.
1872.	— —	*Murchison.*	Siluria, 4th edit., p. 509.
1873.	— —	*Salter.*	Cat. Cambrian and Sil. Foss. Cambridge, p. 176.
1880.	— —	*F. Roemer.*	Lethæa pal., p. 304.
1881.	— —	*Whitfield.*	Bulletin Amer. Mus. Nat. Hist., No. 1, p. 14.
1883.	— —	*F. Roemer.*	Zeitschr. d. deutsch. geol. Gesellsch., p. 707.
1883.	Dictyophyton Danbyi,	*Hinde.*	Cat. Foss. Sponges, p. 131.

Sponges sub-ovate or sub-conical in form, growing from an obtuse basal point, without stem, root, or point of attachment, the base is flattened or convex, the greatest width in some specimens is just above the base, in others about half the height of the Sponge, from this it gradually tapers to the summit, which appears to have been open. The specimens vary between 23 and 30 mm. in height, and from 14 to 17 mm. in width.

The Sponge-wall appears to have been smooth and even; the larger areas of the rectangular meshwork are marked out by more prominent, vertical, and transverse raised lines, and vary from 1·5 to 3 mm. in length, and these are subdivided by finer lines into smaller squares, the sides of which are about ·75 mm. in length. In some cases the stronger lines forming the larger squares are nearly parallel from the base to the summit, whilst in others they converge to each other towards the base.

No spicular structure whatever has been preserved in any of the specimens yet discovered, which are merely casts in a matrix of micaceous sandstone. No structure can be detected in the interior of the specimens.

Mr. Salter, according to M'Coy's statement, referred this species to *Receptaculites;* by M'Coy himself it was placed in the genus *Tetragonis*, Eichwald, and apparently regarded as belonging to the Echinodermata; and in Morris's Catalogue it is also placed in this group. Ferd. Roemer likewise includes this species under *Tetragonis*, and calls attention to the resemblance between the surface characters of another form of this genus and *Dictyophyton.* Subsequently I placed the species in *Dictyophyton*, as its structure, so far as a comparison is possible from merely the casts of the organism, agrees closely with that of *D. tuberosum*, Conrad, the type of the genus. It is now known that the genus *Tetragonis*, Eichwald, is merely a synonym of *Ischadites*, Murch., and its characters markedly differ from those of *Dictyophyton.*

Dictyophyton Danbyi is readily distinguished by its small size and the slighter character of its spicular framework from other species of the genus. The specimens represented on Pl. II, figs. 4, 4 *a*, are the type-forms described by M'Coy, now in the Woodwardian Museum at Cambridge. The other specimen, 4 *b*, represents the concave impressions of two individuals which, with the imperfect casts of five others, are exposed on the surface of a small slab of rock, now in the Museum of the Geological Society, Burlington House.

Distribution.—Silurian: Upper-Ludlow-beds at Brigsteer, Benson, Underbarrow, Kendal, Westmoreland.

12. Hyalostelia gracilis, *Hinde*, sp. nov. Plate I, figs. 5, 5 *a*—5 *e*.

The form of the Sponge unknown, the detached spicules referred to the species are either simple hexactinellids with the normal number of rays, or modified spicules in which one ray or one axis is absent. The vertical axis of the spicules is generally longer than the transverse, and varies in length from ·675 to ·95 mm. The transverse rays are generally imperfect; in some cases they form an oblique angle with the vertical axis of the spicule. The spicular rays, with one exception, are smooth and tapering, and apparently terminate obtusely. They vary from ·05 to ·2 mm. in thickness. The rays in one spicule are furnished with obliquely projecting spines.

Associated with the body-spicules are some fragmentary, elongated, cylindrical rods, about ·12 mm. in thickness, with, in places, minute spines disposed spirally, which may be portions of anchoring spicules. Both these and the body-spicules are siliceous, and their axial canals are usually preserved.

These various forms of spicules were discovered by Mr. J. Smith, of Kilwinning, mingled together in a bed of decayed limestone, and it is probable that they belong to the same species.

Distribution.—Silurian: Wenlock strata, near Craven Arms, Shropshire (J. Smith).

13. Ischadites Lindstrœmi, *Hinde*. Plate II, figs. 2, 2 *a*.

1884. Ischadites Lindstrœmi, *Hinde*. Quart. Journ. Geol. Soc., vol. xl, pl. xxxvi, fig. 2.

— Grindrodi, ? *Salter*, MS. (See Bigsby's Thesaurus Siluricus, p. 4, 1868.)

Hemispherical or ellipsoidal Sponges, with broad, markedly concave bases, and round or somewhat depressed summits. They vary from 50 to 100 mm. in width; on account of the compressed condition of all the specimens their height has not been ascertained.

The rhomboidal spicular plates in the basal and zonal regions of the Sponge vary from 3·5 to 5 mm. in extreme width, whilst near the summit aperture they are not more than 1 mm. wide. The summit aperture is about 3 mm. in width.

This species is distinguished from *Ischadites Koenigii*, Murch., by its larger proportions, the concavity of the base, and the somewhat larger dimensions of the spicular summit-plates. Only casts of this species are known, and these generally exhibit the concave basal portion; but in specimens from the Grindrod Collection, now in the Natural History Museum at Oxford, the upper surface is exposed to view; and in one instance the casts of the spicular plates are preserved, as shown in fig. 2 *a*.

As in the case of *I. Koenigii*, this species likewise appears to have been gregarious, several individuals occurring on the same slab of rock in close proximity to each other.

In Bigsby's 'Thesaurus Siluricus' *Ischadites Grindrodi*, Salter, MS. is included; this name may possibly refer to the present species, but as neither specific description nor figure of it has ever been published, and there are no means of definitely ascertaining the type form, I have judged it best to adopt a distinct name for the present species in order to avoid ambiguity.

Distribution.—Silurian: Wenlock shale, Malvern. Lower Ludlow; Ledbury. Also in the lowest beds of the Silurian at Petesvik and Hablingbo, Isle of Gothland (Lindström).

Genus.—Amphispongia, *Salter.*

1861. Memoirs Geological Survey Great Britain, Sheet 32 Scotland, p. 135.

Sponges elongated-oval or elliptical in outline, greatly compressed, free, with rounded bases and summits. No traces of a canal-system. The basal portion consists of robust, relatively large, conical spicules, disposed side by side nearly in contact with each other, so that their pointed ends converge to the central axis of the Sponge, whilst their distal rounded summits form the basal surface. The upper portion of the Sponge consists of slender four- and five-rayed spicules with the rays at right angles to each other. These apparently are modified hexactinellid spicules. The spicules are regularly arranged so that their rays lap over and

dovetail into each other and form a close, even spicular tissue. There are traces of slender filiform spicules forming an outer layer to the upper portion of the Sponge. The spicules are not organically united together.

Mr. Salter regarded *Amphispongia* as a Calcisponge, and Dr. Bowerbank held the same opinion. The spicules of the upper portion of the Sponge were described as three-rayed forms similar to those of recent Calcisponges, whilst those of the basal portion were stated to be bundles of simple spicules. The fact that in all cases the spicular structures are now only represented by moulds or casts, which are mostly empty or occasionally refilled with a loose powdery iron-rust, not only gave rise to the mistake as to the form of the spicules but also confirmed the idea that they must have been originally of carbonate of lime, since at the time when Salter described this genus it was generally supposed that siliceous fossils would not be liable to dissolution the same as structures of calcite. It is clear, however, from the form of the spicules and from the presence of five rays in many of them, that they are related to siliceous hexactinellids, and the existence of undoubted siliceous Sponges, such as *Plectoderma* for example, in these same beds, and for the most part in a similar condition of preservation, shows the untenability of the theory that since the spicules are dissolved they must necessarily have been originally calcareous.

But whilst the character of the spicules of the upper portion of the Sponge shows its relationship to the Hexactinellidæ, the mode in which they are interwoven together is altogether distinct from that of any other member of this group, and the presence and the arrangement of the peculiar conical spicules in the basal portion of the Sponge is similarly abnormal, so that *Amphispongia* stands quite apart from other hexactinellids.

The genus is only represented by a single species, which appears to be limited to a definite stratum of decayed limestone of Upper-Ludlow age in the Pentland Hills.

14. Amphispongia oblonga, *Salter*. Plate III, figs. 3, 3 *a*—3 *f*.

1861.	Amphispongia	oblonga,	*Salter*. Mem. Geol. Survey Great Britain, Sheet 32 Scotland, p. 135, t. 2, f. 3.
1872.	—	—	*Murchison*. Siluria, 4th edit., p. 509.
1877.	—	—	*Zittel*. Studien, Abtheil. 1, p. 45, Note.
1879.	—	—	*Nicholson*. Manual of Palæontology, 2nd ed., vol. i, p. 135, figs. 33 *c*, *d*.
1880.	—	—	*F. Roemer*. Lethæa pal., p. 317.
1883.	—	—	*Hinde*. Cat. Foss. Sponges, p. 154, pl. xxxiii, figs. 12, 12 *a*—12 *d*.

The general outline of these Sponges is that of an elongated ellipse; the sides are occasionally straight, but usually slightly curved. The basal portion is in most cases narrower than the summit, it is evenly rounded, and there are no traces of stem or of fibres by which it might have been attached. The basal and lateral margins are clearly defined; the summit portion is less frequently exposed, but it appears to have been evenly rounded. There is considerable variation in the size of different specimens; a small example measures 17 mm. in length by 8 mm. in width, whilst a large form is 60 mm. in height by 23 mm. in width. In the present compressed condition the thickness of the Sponge is inconsiderable, about 1 mm. in the upper portion and 2·5 mm. at the base.

It is uncertain whether a central cloacal cavity existed, but it is possible that the upper portion of the Sponge may have originally been a hollow sac with thin walls, which are now compressed together. In one specimen I have seen indications of a narrow cavity in the basal portion.

The conical spicules extended from one-fourth to one-half of the entire length of the Sponge. Judging from casts, their surfaces were smooth and even, and they tapered evenly from the rounded head to the pointed extremity. They varied from 2 to 3 mm. in length, and from ·5 to 1 mm. in thickness. At the extreme base of the Sponge these conical spicules pointed directly upwards, whilst on the sides they are disposed obliquely to its axis, their points being directed downwards and inwards. The four- and five-rayed spicules forming the upper portion of the Sponge are very much smaller than the conical basal spicules, on which they directly rest. They are so closely arranged that, as a rule, only the casts of one spicular axis and the small aperture of a third ray can be seen on the exposed surface of the Sponge, and their real forms can only be ascertained from the casts of the detached individuals, which are fairly abundant in the matrix associated with the conical spicules. The rays of the smaller spicules are straight, they very gradually taper from the central node, and they vary from ·5 to 1 mm. in length, and about ·12 mm. in thickness. The slender filiform spicules are seldom preserved, they appear to have been arranged somewhat obliquely to the length of the Sponge, and to have been restricted to its upper portion.

All the examples of this species hitherto found are preserved as casts in a soft brown, micaceous, somewhat shaly rock. They are extended on the bedding-plane of the rock, sometimes in a uniform direction with respect to each other, and in such numbers as nearly entirely to cover the surface (Pl. III, fig. 3).

The type of the species is now in the Museum of the Geological Survey, Jermyn Street, but much better preserved specimens have been discovered since the form was first described, and these are now in the British Museum, and in the Museum of Science and Art, Edinburgh.

Distribution.—Silurian: Upper-Ludlow strata; Wetherlawlinn, Pentland Hills, near Edinburgh.

Sub-Order.—Octactinellidæ.

Genus.—Astræospongia, *F. Roemer.*

1860. Silur. Fauna Tennessee, p. 14.

Syn.—Blumenbachium, *F. Roemer* (non *Koenig*) ; Astræospongium, *F. Roemer ;* Octacium, *Schlüter.*

Generic Characters.—Sponges discoid or shallow cup-shaped in form, and without stem or any surface of attachment. No special canal-system indicated in the skeleton, which is composed of spicules having six rays extending in a plane from a common centre, at equal angles from each other, and with a vertical axis. One or both rays of the vertical axis may be reduced or not be developed. The spicules are irregularly arranged, with their horizontal rays generally parallel to the surface of the Sponge ; they are quite free from each other.

Though the spicular elements of the skeleton in this genus do not appear to have been organically attached together, entire Sponges are of not infrequent occurrence. In these the spicules are now cemented together by the matrix, and they are best preserved on the weathered surface of the Sponge. The rays in some of the larger spicules show, when weathered, longitudinal open furrows, indicating the presence of canals. Many of the examples of this genus are now composed of carbonate of lime, and even the detached spicules met with in the rocks consist of the same mineral. In some, however, the exterior is of carbonate of lime, whilst the interior is a mass of chalcedonic silica, in which the spicular structure has been obliterated. The frequent occurrence of these calcitic specimens has given rise to the belief that the Sponges originally consisted of this mineral, and Ferd. Roemer[1] supports this view by the statement that other Sponges, as *Astylospongia* for example, occurring, with *Astræospongia* in the same beds in Tennessee, are completely silicified. But it does not thereby follow that this latter genus is a Calcisponge, since we know that many of the Silurian examples of *Aulocopium*, a generally recognised siliceous Sponge, are partly of calcite and partly of chalcedonic silica, like some of the Tennessee specimens of *Astræospongia.* The form and general character of the spicules of this genus, moreover, do not indicate any affinity with recognised Calcisponges, and I therefore regard the calcareous specimens as replacements after silica.

The spicules of *Astræospongia* have been described by F. Roemer as consisting only of six horizontal rays, and Schlüter,[2] maintaining the same opinion, has con-

[1] 'Lethæa palæozoica' (1880), p. 314.

[2] 'Sitzungsb. d. niederrhein. Gesellsch. in Bonn,' 1885, p. 151.

stituted a new genus, *Octacium*, for spicules in which a vertical axis is present in addition to the horizontal rays. But Zittel[1] has pointed out that the spicules, even in the typical species, show indications of a vertical axis, though one or both of its rays may be reduced to a mere rudimentary process, and therefore the fully developed spicules in *Astræospongia* may be regarded as possessing eight rays.

The spicules of this genus are so distinctly marked off from those of any other group of Sponges that in my opinion they characterise a separate sub-order. The constancy and the regular disposition of the six horizontal rays, and the additional rays of the vertical axis, clearly show that the genus cannot be ranked with the Hexactinellidæ. The same features likewise distinguish it from any of the genera included in the Heteractinellidæ, though some of the spicules of *Tholiasterella*, consisting of six horizontal rays and a vertical ray, bear a certain resemblance to those of *Astræospongia* (Pl. VII, figs. 1 *c*, 1 *d*). But in *Tholiasterella* the horizontal rays are very inconstant, varying from five to nine in number, and further, their mode of union with each other also indicates the absence of any real affinity between these groups.

The genus *Astræospongia* makes its first appearance in the Silurian (Niagara group or Wenlock) and passes up into the Devonian. It occurs in North America; Isle of Gothland, Sweden; England; Eifel, Germany; and in Belgium.

15. Astræospongia patina, *F. Roemer*. Plate I, figs. 7, 7 *a*—7 *d*.

1861.	Astræospongia	patina,	*F. Roemer*.	Fossile Fauna d. Silur. Geschiebe von Sadewitz, p. 14, pl. iii, figs, 5 *a*—5 *d*.
1880.	—	—	—	Lethæa pal., p. 315.
1883.	—	—	*Hinde*.	Cat. Foss. Sponges, p. 149, pl. xxxi, fig. 5.

The Sponges are discoid, with rounded, convex bases, and shallow, concave upper surfaces. The type specimen is stated to be 41 mm. in width and 20 mm. in height.

The skeletal-spicules exhibit well-marked, flattened, central discs; the rays taper very slightly as a rule, and terminate obtusely. In many, only the six horizontal rays are developed, in others one ray of the vertical axis is present as a small projection from the centre of the disc, whilst more rarely some possess both rays of the vertical axis. In one abnormal spicule only three horizontal rays are

[1] 'Handbuch der Pal.,' Bd. i, 1879, p. 185.

present. The spicules vary from ·36 to 1·5 mm. in diameter, and the rays are from ·033 to ·137 mm. in thickness.

Only detached spicules of this species have, as yet, been recognised in this country, and these were discovered, sparsely distributed in decayed shaly limestones, by Mr. John Smith, of Kilwinning. The spicules are all imperfect; they correspond very closely with those of the type form from the Glacial Drift of Sadewitz, Lower Silesia, and with the detached spicules which I obtained from the Isle of Gothland. They are now of calcite.

Distribution.—Silurian: Wenlock shale, Wren's Nest, Dudley; Dormington; Lincoln Hill; Benthall Edge; Malvern, at the west end of the Tunnel.

Also in the Isle of Gothland and in the Drift of Sadewitz, Northern Germany.

DEVONIAN SPONGES.

Family.—Receptaculitidæ.

Genus.—Sphærospongia, *Pengelly.*

1861. Geologist, vol. iv, p. 340.

Syn.—Sphæronites, *Phillips, F. Roemer, Bowerbank, Austin;* Echinosphærites, *Murchison, Keyserling, Verneuil;* Pasceolus, *Kayser;* Polygonosphærites, *F. Roemer, Zittel.*

Generic Characters.—Pyriform, cup- or funnel-shaped Sponges, growing from an obtusely-pointed, frequently incurved, base; without stem or attachment of any kind. The summit in some specimens is dome-shaped and appears to have been mostly inclosed, whilst in other examples it is widely open.

The outer surface of the Sponge-wall consists of smooth, hexagonal plates, regularly arranged in quincunx. Beneath the plates are the four transverse rays of the spicules, which form vertical and concentric ridges on the inner side of the Sponge-wall. An entering ray, like that in *Ischadites*, is either absent or only represented by a short knob-like process.

This genus was first referred by Mr. W. J. Broderip to the Tunicata; then it was placed by Prof. J. Phillips, as a Cystidean, in the genus *Sphæronites*, Hisinger; and subsequently Mr. Pengelly, who first discovered the characters of the interior, described it as a Sponge, and constituted for it the genus *Sphærospongia.* Still later, the form was referred by Kayser to *Pasceolus*, Billings; and Ferd. Roemer, whilst recognising its relationship to *Receptaculites*, Defrance,

denied its claim to be regarded as a Sponge, and, therefore, proposed for it the generic name of *Polygonosphærites*.

This genus is distinguished from other members of the family by its form, by the regular hexagonal figure of the spicular plates, and by the absence of entering spicular rays.

The genus appears to be limited to Devonian strata; it has been met with in Devonshire, in Germany, and in Russia.

16. Sphærospongia tessellata, *Phillips*, sp. Plate IV, figs. 2, 2 *a*—2 *d*.

1832 Tunicate fossil, *Broderip*. Trans. Geol. Soc., ser. 2, vol. iii, p. 164, pl. xx, figs. 1, 2.
1841. Sphæronites tessellatus, *Phill.* Pal. Foss. Devon, &c., p. 135, pl. lix, fig. 49.
1844. — — *F. Roemer.* Rhein. Uebergangsgeb., p. 64.
1845. Echinosphærites — *Murch., Keyserl., Vern.* Geology of Russia, p. 381, pl. xxvii, fig. 7.
1845. Sphæronites — *Bowerbank.* Ann. and Mag. Nat. Hist., vol. xv, p. 299.
1845. — — *Austin.* Idem., p. 406.
1854. Echinosphærites — *Morris.* Cat. Brit. Foss., p. 79.
1850–56. Proboscis of crinoid, *G. and F. Sandberger.* Verstein. des Rhein. Schicht.-Syst., pp. 384, 385.
1861. Sphærospongia tessellata, *Pengelly.* Geologist, vol. iv, p. 340, pl. v.
1875. Pasceolus tessellatus et Rathi, *Kayser.* Zeitschr. d. deutsch. geologisch. Gesellsch, p. 780, pl. xx.
1880. Polygonosphærites tessellatus, *F. Roemer.* Leth. geogn., Th. 1, p. 297, fig. 54.
1880. — — *Zittel.* Handb. der pal., vol. i, p. 728.
1883. Dictyophyton Gerolsteinense, *F. Roemer.* Zeitschr. d. deutsch. geologisch. Gesellsch., p. 706, figs. *a*, *b*.
1884. Sphærospongia tessellata, *Hinde.* Quart. Journ. Geol. Soc., vol. xl, p. 840, pl. xxxvii, figs. 1, 1 *a*—1 *c*.

The examples of this species show many gradations of form between open cup-shaped and pyriform, and they are equally as variable in size. The type specimen, though imperfect, is 85 mm. in height and 115 mm. in width near the summit. The average height of a number of examples in the British Museum is 60 mm., and they are nearly of the same width.

The hexagonal spicular plates, forming the outer surface of the Sponge, are nearly flat, with a small central rounded elevation, which, however, is only seen in the best-preserved specimens; the plates also exhibit delicate concentric lines, resembling lines of growth, and occasionally their margins are slightly elevated. The plates near the base of the Sponge are the smallest, whilst those of the middle and upper portions are about equal in size. They vary from 2·5 mm. to 7·5 mm. in width. Though apparently the plates are in close contact with each other, yet many specimens show narrow linear interspaces between their margins.

The transverse spicular rays, forming vertical and concentric ridges within the Sponge, gradually taper from their central node and terminate obtusely; those extending horizontally are not infrequently curved and less regular than those of the vertical ridges. The rays are slightly unequal in length, and frequently overlap, so that when fused together by fossilization their individual forms are not readily distinguishable.

As a general rule, the specimens showing the exterior surface are infilled with a solid calcareous matrix, whilst in the hollow specimens the surface-plates are concealed by the rock. Fragments, however, occur in which both the outer and inner structures of the wall can be recognised. In all the specimens discovered, the structures are replaced by carbonate of lime.

In a lately published paper,[1] Prof. Schlüter proposes to include as distinct species of *Sphærospongia*, *Scyphia cornucopiæ*, Goldfuss, *Pasceolus Rathi*, Kayser, and *Dictyophyton gerolsteinense*, F. Roemer, as well as three new species, *S. sculpta*, *S. vichtensis*, and *S. megarhaphis*. The characters of these species for the most part depend upon slight differences in the size of the specimens and of the individual spicular plates of their surfaces, and the specimens are very fragmentary. Judging from the great variability in these features shown in the suite of specimens of *S. tessellata* from Newton-Bushell, I do not think these differences have any specific value, at least as regards the forms described by Goldfuss, Kayser, and F. Roemer, whilst I hesitate to express an opinion as to the new species proposed.

The type of the species, represented on Pl. IV, fig. 2, is now in the Museum of the Geological Survey, Jermyn Street.

Distribution.—Middle Devonian: Newton-Bushell, Devonshire. Also at Vilmar, Nassau; Eifel, Germany; River Jolva, near Bogoslofsk, Ural, Russia.

[1] 'Zeitschr. d. deutschen geolog. Gesellschaft,' 1887, p. 1.

Genus.—Receptaculites, *Defrance.*

1827. Dictionnaire des Sciences Naturelles, tome 45, Atlas, pl. 68.

Syn.—Coscinopora (in part), *Goldfuss*, *D. Dale Owen.*

Generic Characters.—Cup- or platter-shaped Sponges, growing from a small inverted conical nucleus, and frequently reaching considerable dimensions. Wall thick, the outer or under surface consisting of rhomboidal spicular plates similar to those in *Ischadites*, and, as in this genus, disposed in decussating lines. The four transverse or horizontal spicular rays form radial and concentric lines beneath the surface-plates. The vertical or entering ray of the spicules is subcylindrical, frequently constricted near its junction with the transverse rays; at its inner end it expands, to form a small horizontal plate, which is traversed by horizontal canals. By the junction of the inner plates with each other a distinct inner or upper layer of the Sponge-wall is formed, and in one species at least this layer is perforated by cylindrical canals, thus giving communication to the interior space of the Sponge-wall.

This genus is distinguished from all others included in the family by the presence of an inner layer formed by the development of small plates at the extremity of the entering ray of the spicules.

Owing in part to the peculiar aspect of examples of this genus under different conditions of preservation, various views have been held as to its character and affinities. By Defrance and Eichwald the hollow casts of the vertical spicular rays were believed to be polyp-cells, and the genus was placed with Corals. Salter at first regarded it as a Foraminifer allied to the family of the Orbitolitidæ; Billings placed it with Sponges on account of a supposed resemblance to the gemmules of *Spongilla;* by Dames it was placed a second time with the Foraminifera as the type of a family near the Orbitolitidæ; and still later Gümbel retained it in the same class, but included it in the family of the Dactyloporidæ.

The genus makes its first appearance in the Ordovician of North America, Russia, and the Arctic regions; it is present in the Silurian proper at Malvern; Australia, and doubtfully in Canada; in the Devonian of Devonshire, Belgium, the Eifel, and elsewhere in Germany as well as in Canada; and a single somewhat doubtful species is recorded from the Carboniferous Limestone of Silesia.

17. RECEPTACULITES NEPTUNI, *Defrance*. Plate II, fig. 3, and Plate IV, fig. 1.

1827. RECEPTACULITES NEPTUNI, *Defrance*. Dict. des Sciences Nat., vol. xlv, p. 5, Atlas, pl. lxviii, figs. 1 *a*, 1 *b*, 1 *c*, 1 *d*.
1826–33. COSCINOPORA PLACENTA ET SULCATA, *Goldfuss*. Petref. Germ., Th. 1, p. 31, pl. xix, figs. 18, 19.
1842. RECEPTACULITES NEPTUNI, *Archiac and Verneuil*. Trans. Geol. Soc., ser. ii, pt. 2, p. 407.
1844. — — *F. Roemer*. Rhein. Uebergangsgeb., p. 59.
1852. — — *Quenstedt*. Handb. d. Petref., p. 670, pl. lx, fig. 18.
1868. — — *Dames*. Zeitsch. d. deutsch. geol. Gesellsch., Bd. xx, p. 483, pl. x, fig. 1.
1875. — — *Gümbel*. Beiträge Abhandl. d. k. bay. Akad. der Wiss., Cl. ii, Bd. xii, Ab. 1, p. 169, pl. A.
1878. — — *Quenstedt*. Petref. Deutschl., Bd. v, p. 596, pl. 142, fig. 20.
1878. — SCYPHIOIDES, *Quenstedt*. Idem., p. 586, p. 142, figs. 15, 16.
1879. — NEPTUNI, *Nicholson*. Man. Pal., vol. i, p. 127, fig. 29.
1876–80. — — *Zittel*. Handb. d. Pal., p. 84, fig. 20.
1880. — — *F. Roemer*. Lethæa pal., vol. i, p. 290, Atlas, pl. xxxv, figs. 7 *a*, *b*, *c*.
1882. — — *T. R. Jones*. Cat. Foss. Foram. Brit. Mus., p. 4.
1884. — — *Hinde*. Quart. Journ. Geol. Soc., vol. xl, p. 841.
1885. — — *Vosmaer*. Porifera. Bronn's Klassen u. Ordnungen d. Thier-Reichs, Bd. ii, p. 275.

Sponges varying in form from flattened discs with a circular outline, to open cups, and ranging from 65 to 180 mm. in diameter. The walls, as a rule, gradually increase in thickness, from the conical nucleus, where they are about 3 mm. in thickness, towards the margin of the disc or cup, where they attain a thickness of 10 to 15 mm., and in one exceptional example 20 mm.

The rhomboidal spicular plates of the outer or under surface of the Sponge-wall are usually flat, though in some specimens they become concave through pressure; their edges are thin and usually crenulated beneath. They vary from 4 to 5·5 mm. in width. They are disposed so that a linear interspace exists between adjoining plates, which is shown by the curved decussating ridges in the casts of the outer surface. The transverse or horizontal spicular rays are conical, from 1 mm. to 1·5 in thickness; they usually extend beyond the respective head-

plates, and overlap the rays of adjoining spicules. The ray pointing to the outer margin of the Sponge not infrequently projects over the spicular plate in advance of it. The entering or vertical ray of the spicule is usually contracted immediately beneath its junction with the transverse rays, it then expands and is nearly evenly cylindrical to its junction with the plate of the inner wall. The characters of the plates forming the inner or upper wall in this species have not clearly been made out. They appear to be sub-quadrate in form, and in close contact with each other. It is doubtful whether there were perforations at the angles of the plates, as is clearly the case in *R. occidentalis*, Salter, and in a specimen from the Devonian of Canada, which, in all other respects, resembles the European forms of this species.

The only undoubted example of this species from British strata is a fragmentary individual discovered by the late A. Champernowne, Esq., F.G.S., showing an impression in hardened mudstone of a portion of the inner surface of the wall and transverse sections of the vertical spicular rays (Pl. IV, fig. 1). Fragmentary specimens likewise occur in Wenlock strata at Malvern, which may provisionally be referred to this species, though the characters preserved are insufficient for satisfactory determination. They consist of impressions of the under or outer surface of the wall of flattened specimens of at least 120 mm. in diameter, showing the lozenge-shaped depressions formed by the casts of the spicular plates and traces of the transverse rays beneath them (Pl. II, fig. 3). In none of the specimens is the structure clearly shown, and the principal grounds for referring them to *R. Neptuni* are the correspondence in the form and dimensions and in the crenulated margins of these outer plates to those of typical forms of this species as figured by Gümbel.[1]

Distribution.—Silurian: Wenlock strata, Malvern. Middle Devonian: Mudstone Bay, Devonshire. Also in Devonian strata at Chimay, Couvin, and other localities in Belgium, Ober-Kunzendorf, Silesia; Eifel, Germany; near Widder, Ontario, Canada.

Sub-Order.—OCTACTINELLIDÆ.

18. ASTRÆOSPONGIA DEVONIENSIS, *Hinde*, sp. nov. Plate IV, figs. 8 *a*—8 *c*.

The form of the Sponge unknown; the species is based on detached spicules in which both the rays of the vertical axis are developed, as well as the six horizontal rays. The rays are robust, conical, circular, or slightly compressed in

[1] 'Beiträge Abhandl. d. k. bay. Akad. der Wiss.,' Cl. ii, Bd. xii, pl. A, figs. 3 *a*, 4 *a*.

transverse section, tapering evenly but somewhat abruptly, from the central disc to an obtuse termination. The rays forming the vertical axis, when complete, appear to be as long as the horizontal rays. There is considerable variation in the dimensions of the spicules; the individual rays, measured from the centre of the disc, vary from 1·2 mm. to 3·2 mm. in length and from ·3 to ·6 mm. in thickness at their bases.

The spicules of this species are characterised by the tapering conical form of the rays, and by the development of the rays of the vertical axis. In this latter feature they agree with spicules described by Prof. Schlüter from Devonian Rocks of the Eifel, under the name of *Octacium rhenanum*;[1] but, judging from the figures and measurements given by Prof. Schlüter, the rays in our species, besides being larger, taper more abruptly. In *Astræospongia meniscoides*,[2] Dewalque, also from the Eifel, the spicules are larger than those of the present species, the rays are fusiform rather than conical, and no mention is made of the presence of vertical rays. In *A. Hamiltonensis*, Meek and Worthen,[3] from the Devonian of North America, the spicules are smaller, and do not appear to possess vertical rays.

The forms described and figured were discovered by Mr. J. Smith, of Kilwinning, in decayed limestones. They are now of crystalline calcite, their surfaces are much eroded, and in some instances partially obscured by matrix.

Distribution.—Middle Devonian: Newton Abbott, Devonshire.

CARBONIFEROUS SPONGES.

Sub-Order.—Monactinellidæ.

Genus.—Reniera, *O. Schmidt.*

1870. Die Spongien des adriatischen Meeres, p. 72.

Syn.—Rayneria, *Nardo;* Pellina, *O. Schmidt;* Prianos, *Gray.*

Sponges of variable form. The skeleton consists of acerate and cylindrical spicules, which are disposed so as to form a polygonal meshwork; the spicules held together at their ends by spongin.

The connected skeletons of Sponges of this genus are unknown in the fossil

[1] 'Sitzungsb. der niederrhein. Gesellsch. Bonn,' p. 151; 'Zeitschrift d. deutschen geolog. Gesellschaft,' 1887, p. 23, Taf. ii, figs. 7—9.

[2] 'Bull. de l'Acad. Roy. de Belgique,' vol. xxxiv, 1872, p. 24, pl. xxvi.

[3] 'Geol. Surv. Illinois,' vol. iii, p. 419, pl. x, fig. 6.

state, and owing to the fragile manner in which the spicules are held together in the existing species, their preservation as fossils in their normal positions can hardly be expected. Detached spicules closely resembling in form those of existing examples of the genus, but for the most part of larger proportions, are, however, of not infrequent occurrence in Carboniferous and newer strata, and they may provisionally be ranged in this genus.

I have followed Vosmaer in regarding O. Schmidt as the author of the genus, since he not only modified Nardo's original name, but was the first to define the characters of the Sponges assigned to the genus.

19. Reniera Carteri, *Hinde*. Plate IV, figs. 5, 5*a*—5*f*.

1879. Spicule of a Renierid Sponge, *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. iii, p. 144, pl. xxi, fig. 11.
1883. Reniera ? Carteri, *Hinde*. Cat. Foss. Sponges, p. 19, pl. i, fig. 8.

The detached spicules on which this species is based are smooth, cylindrical, gently arcuate, or with a nearly straight central portion and somewhat abruptly incurved extremities, which in all cases are obtusely rounded. They range from ·8 to 2·5 mm. in length and from ·11 to ·22 mm. in thickness. There are numerous gradations between the extreme forms, which indicate that they probably all belong to a single species.

The spicules are now composed nearly entirely of chalcedonic silica; in a few instances the silica is crystalline. They are now usually solid throughout, in only a single example of those which have come under my notice has the axial canal been preserved. They are fairly abundant and well preserved.

Distribution.—Lower Carboniferous: Upper Limestone series at Glencart, Dalry, Ayrshire.

20. Reniera scitula, *Hinde*, sp. nov. Plate IV, fig. 4.

1880. Reniera ? *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. vi, p. 212, pl. xiv, fig. 14.

The spicules included in this species are cylindrical, smooth, gently arcuate, and with evenly rounded extremities. They vary from ·5 mm. to ·9 mm. in length, and from ·09 mm. to ·15 mm. in thickness. They are now partly of chalcedonic and

partly of crystalline silica. Traces of the axial canal are present in some examples.

These spicules are distinctly smaller and more evenly arcuate than those of *R. Carteri*, from the Carboniferous of Ayrshire. They were obtained by Mr. J. Wright from the decayed chert-bed at Ben Bulben, and described by Mr. H. J. Carter, F.R.S., as "sausage-shaped spicules like those of some of the Reniera of the present day.

Distribution.—Upper beds of Carboniferous Limestone, Ben Bulben, Sligo, Ireland.

21. Reniera clavata, *Hinde*, sp. nov. Plate IX, figs. 5, 5 *a*, 5 *b*.

The spicules of this species are cylindrical, gently arcuate, with slightly inflated extremities, their surfaces smooth and even. They vary from ·36 mm. to ·53 mm. in length, and from ·06 to ·09 mm. in thickness. They are smaller than the preceding species, and characterised by their slightly tumid extremities.

These spicules are the most abundant and widely distributed forms in the Carboniferous Sponge-beds, which in places are filled with them.

Distribution.—Yoredale series: Richmond, Arkendale, Harrogate, Yorkshire; Halkin, Henblas, near Holywell, Gt. Orme's Head, North Wales. Carboniferous Limestone: Clitheroe, Lancashire. Middle Limestone or Calp series: near Dublin.

22. Reniera virga, *Hinde*, sp. nov. Plate IX, figs. 6, 6 *a*, 6 *b*.

This name is proposed for elongated cylindrical spicules, smooth, evenly rounded at both ends, and gently arcuate. In some specimens one end of the spicule is slightly smaller than the other. They vary from ·5 to ·65 mm. in length, and from ·05 to ·06 mm. in thickness. They are distinguished from *R. clavata* by the absence of any inflation at their ends, and they are much more slender forms than *R. scitula*.

Distribution.—Carboniferous Limestone: Clitheroe, Lancashire. Yoredale series: Richmond, Yorkshire; Trelogan, Flintshire. Upper Limestones: Ben Bulben, Sligo.

23. Reniera gracilis, *Hinde*. Plate IX, figs. 7, 7 *a*, *b*.

1885. Reniera gracilis, *Hinde*. Beds of Sponge-Remains in Lower and Upper Greensand, Phil. Trans., p. 436, pl. xli, figs. 1, 1 *b*.

Cylindrical spicules, gently arcuate, smooth, with evenly rounded ends. Average length ·4 mm., thickness ·05 mm. These spicules correspond closely with those described under the above name from the Lower and Upper Greensand of Surrey and Devonshire. They are distinctly shorter than the spicules of *R. virgata*.

Distribution.—Yoredale series: Richmond, Yorkshire.

24. Reniera Zitteli, *Počta*. Plate IX, figs. 8, 8 *a*—8 *c*.

1884. Reniera Zitteli, *Počta*. Sitzungsber. der königl. böhm. Gesellsch. der Wiss., vol. 1884 (1885), p. 8, pl. i, figs. 10—14.
1885. — — *Hinde*. Phil. Trans., p. 437, pl. xli, figs. 4—4 *e*.

Acerate spicules, straight or gently arcuate, smooth, either fusiform and gently tapering to both ends, or nearly even throughout and somewhat abruptly pointed. Length from ·3 to ·5 mm. and from ·03 to ·04 mm. in thickness.

These Carboniferous spicules cannot be distinguished from the forms occurring in the Greensands of Surrey and Devonshire, and in the Cretaceous strata of Bohemia and Westphalia.

Distribution.—Yoredale series: Richmond, Yorkshire; Halkin, Henblas, near Holywell, North Wales. Carboniferous Limestone: Clitheroe. Upper Limestone series: Benachlan, Ben Bulben, Sligo.

25. Reniera bacillum, *Hinde*, sp. nov. Plate IX, fig. 9.

Very slender cylindrical spicules, either gently curved throughout their length, or somewhat abruptly incurved near one or both ends. Their surfaces are smooth, and their extremities evenly rounded. They vary from ·23 mm. to ·5 mm. in length, and ·02 mm. in thickness. These forms are readily distinguishable from those previously described by their slender proportions. They are extremely abundant in some of the cherty Sponge-beds, which are mainly composed of their minute

forms. On weathered surfaces of these beds the spicules have the appearance of a closely felted mass of delicate threads.

Distribution.—Yoredale series: near Harrogate, Yorkshire; Trelogan, Gronant, Flintshire. Upper Limestone series: Benachlan, Fermanagh.

Genus.—AXINELLA, *O. Schmidt.*

1862. Die Spongien des adriatischen Meeres, p. 60.

Branching fibrous Sponges. Spicules acuate or acerate, straight or curved. In the axial portion of the Sponge the spongin is more developed than near the periphery (Vosmaer).

The genus is based on Sponges now existing in the Mediterranean. Entire fossil forms are unknown, but detached spicules, closely resembling those of existing species, are present in Carboniferous strata and more abundantly in the Greensand and Chalk, and may provisionally be referred to the genus.

26. AXINELLA VETUSTA, *Hinde*, sp. nov. Plate IV, fig. 6.

The spicules included in this species are smooth, robust acuates, with evenly rounded summits, gently curved, retaining an equal thickness for about one half their length, then gently tapering to an obtuse point. The specimen figured is 2·3 mm. in length by ·2 mm. in thickness.

This form of spicule is not known earlier than in the Carboniferous Rocks, where it is of rare occurrence.

Distribution.—Carboniferous Limestone: Clitheroe, Lancashire. Upper Limestone series: Glencart, Dalry (J. Smith).

27. AXINELLA PAXILLUS, *Hinde*, sp. nov. Plate IX, fig. 10.

The spicules in this form are smooth, nearly or entirely straight, of an even thickness for two-thirds of their length, then gradually tapering to an obtuse point. The summit is slightly inflated. An average specimen is 1·45 mm. in length by ·08 mm. in thickness.

This form approaches closely to spicules included in *Axinella stylus*, Hinde

(' Phil. Trans.,' 1885, Pl. xli, figs. 8 *a—d*), but it has a distinctly inflated summit; it is a much smaller form than the spicules placed under *A. vetusta.*

Distribution.—Carboniferous Limestone: Clitheroe, Lancashire.

Genus.—Haplistion, *Young and Young. Emend. Hinde.*

1877. Annals and Mag. Nat. Hist., ser. 4, vol. xx, p. 428.

Syn.—Rhaphidhistia, *Carter;* Dysidea (in part), *Carter.*

Generic Characters.—Sponges small, ovoid, spheroidal, or discoidal in form, destitute of stem. Skeleton consisting of solid, reticulate, anastomosing fibres, which terminate at the surface in small blunt projections. No special dermal layer preserved. No definite canals beyond the irregular open spaces between the fibres. The fibres are composed of minute, straight, or curved acerate spicules, disposed generally parallel with the direction of the fibre, and interlacing with each other.

The authors of the genus state, in their original description, that "no spicules have been recognised as belonging to the fossil, though the teazed-out tissue lining the canals has a tantalising suggestion of spicules about it. It is not, therefore, absolutely certain that we have to do with a siliceous Sponge; it may be that a horny Sponge like *Dysidea* has become siliceous, as have the Brachiopod shells in the same deposit." Through the kindness of Dr. J. R. S. Hunter, of Carluke, I have been enabled to examine the example of *Haplistion Armstrongi*, described and figured by Messrs. Young as the type of the genus, and the same specimen has been here refigured (Pl. V, fig. 1). It shows very distinctly the minute spicules weathered out on the exterior of the fibres, and there can be no doubt that the type of the genus is a siliceous monactinellid Sponge. The oscula referred to by Messrs. Young are merely the irregular apertures between the reticulating fibres, and the canals are of the same character.

The genus *Rhaphidhistia*, Carter, is based on specimens having all the characters of the present genus, which has the priority of publication; and further, the same author has referred to a new species of *Dysidea* specimens which clearly belong to the typical forms of *Haplistion.*

The examples of this genus are of rare occurrence, and they are at present only known from the Carboniferous series of Ayrshire.

28. Haplistion Armstrongi, *Young and Young.* Plate V, figs. 1, 1 *a*, 1 *b*.

1877. Haplistion Armstrongi, *Young and Young.* Ann. and Mag. Nat. Hist., ser. 4, vol xx, p. 428, pl. xv, figs. 31—37.
1878. Dysidea antiqua, *Carter.* Ann. and Mag. Nat. Hist., ser. 5, vol. i, p. 139, pl. x, figs. 7, 8.
1879. Spongelia antiqua, *F. E. Schulze.* Zeitsch. d. wiss. Zool., Bd. xxxii, p. 126.
1883. Haplistion fractum, *Hinde.* Cat. Foss. Sponges, p. 207, pl. xxxviii, figs. 4, 4 *a*.

Fairly complete specimens are sub-spheroidal or ovoid in form, and apparently free. The type-specimen is 16 mm. in length by 13 mm. in thickness. The reticulating fibres vary from ·14 to ·5 mm. in thickness; they form a network with circular, oval, or irregular polygonal apertures, ranging from ·55 to 1 mm. in width; in the interior of the specimen the meshes are somewhat more open than at the surface. The conical projections in which the fibres terminate are nearly equal in length, and approximately at right angles to the surface of the Sponge. The spicules are thickly disposed on the surface of the fibres, they are straight or slightly curved, apparently terminating bluntly. The longest spicule noticed measures ·32 mm., whilst they vary from ·025 to ·04 mm. in thickness.

Perfect examples of this species are extremely rare; as a rule only small, broken up fragments of the fibres are met with. The outer surface of the fibres has generally a brownish appearance, and when fairly well preserved shows the outlines of the component spicules on the exterior. The interior portion of the fibres is of solid white silica, probably resulting from the fusing together of the original spicules. The spicules on the surface are only shown as the result of weathering, they have an eroded granular aspect; and, owing to the manner in which they overlap and are partially fused together, it is difficult to ascertain their perfect forms. In specimens which have been subjected to a greater degree of weathering the brownish tint of the fibres is changed to a rusty yellow, the outlines of the spicules have disappeared, and the surface of the fibres, and oftentimes the interior as well, consists apparently of minute, irregular granular particles of silica, partially cemented together. In this condition the fibres have somewhat the appearance of those of the existing genus *Dysidea*, and on a specimen thus preserved Mr. Carter based the species *Dysidea antiqua*. I am indebted to Mr. J. Thomson for the opportunity of examining the type form described by Mr. Carter, which corresponds in every respect, except in its condition of preservation, with the type of *Haplistion Armstrongi*. The spicules obtained by Mr. Carter from

washing his specimen, and which were supposed to have been incorporated in its fibres, were most probably derived from the débris infilling the interspaces between the fibres, and did not form part of the fibres themselves. In Dr. Hunter's type specimen of *H. Armstrongi*, the interspaces between the fibres were similarly filled with spicules and other débris; but in none of the specimens which have come under my notice is there any structural connection between these extraneous spicules and the fibres.

At the time of describing *Haplistion fractum* I had not seen an authentic specimen of *H. Armstrongi*, but a comparison with those forwarded to me by Dr. Hunter and Mr. J. Smith leaves no doubt that the fragments I named belong to Messrs. Young's species.

Distribution.—Carboniferous. Upper part of Lower Limestone series: Cunningham Baidland, Law Quarry, Dalry, Ayrshire.

29. Haplistion vermiculatum, *Carter* sp. Plate V, figs. 2, 2 *a*.

1878. Rhaphidhistia vermiculata, *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. i, p. 140, pl. ix, figs. 15—19.
1883. — — *Hinde*. Cat. Foss. Sponges, p. 208.

Small, depressed convex, or irregularly rounded Sponges, apparently free. The type-specimen is 12 mm. in width. The fibres either anastomose irregularly, or in some specimens are vertical with transverse connections. At the surface they terminate in blunt conical processes. The fibres vary from ·67 to ·9 mm. in thickness. As in the preceding species they are solid, and are composed of straight and slightly curved spicules, which are interlaced with each other. A fairly long spicule measures ·3 mm.

The typical specimen described and figured by Mr. Carter, now in the collection of Mr. J. Thomson, who kindly forwarded it to me for examination, is depressed convex, with a flattened basal portion, which appears to me to be, in part at least, a fractured surface, but which Mr. Carter regards as a continuous membranous attachment, now lapidified. Mr. Carter further described the fibres as belonging probably to a fossil example of *Hydractinia* on which the Sponge was parasitic. It seems to me, however, more probable that, as in *H. Armstrongi*, the fibres of this species were throughout composed of interlacing acerate, siliceous spicules, which are now, with the exception of those weathered out on the surface, indistinguishably fused together. I do not think the fibres were originally hollow as stated by Mr. Carter; the cavities in them appear to result from erosion. The spicules in the type-specimen, as well as in others sent to me by Mr. J. Smith,

are but poorly preserved. I have been unable to detect any of a vermiform figure as represented by Mr. Carter.

This species differs from *H. Armstrongi* in its mode of growth, in the more robust character of the fibres, and in the somewhat greater thickness of the spicules.

Distribution.—Carboniferous: Upper part of Lower Limestone series; Cunningham Baidland, Law Quarry, Dalry, Ayrshire.

Sub-Order.—TETRACTINELLIDÆ.

Genus.—GEODITES, *Carter.*

1871. Annals and Mag. Nat. Hist., ser. 4, vol. vii, p. 129.

Generic Characters.—Sponges consisting of skeletal-spicules with bifid or trifid summit-rays and elongated shafts, and also of large acerate spicules and a dermal layer of minute globate or reniform spicules.

No formal definition of this genus was given by Mr. Carter, who proposed it to include detached spicules of the forms indicated, which are similar to those present in the existing genus, *Geodia*, Lam., and, with the exception of the dermal globular spicules, in *Stelletta*, Schmidt, and other allied genera. As the differences which characterise the recent genera of this group (of which *Geodia* may be accepted as the representative form) cannot be recognised in the detached fossil spicules, it seems preferable to adopt for them the common generic term proposed by Mr. Carter.

The acerate spicules in different species of this genus vary but little in form, and no satisfactory distinctions can be based on their relative proportions; but the characters of the bifid and trifid spicules appear to be sufficiently constant to permit specific distinctions to be based on them.

Owing to the fragile manner in which the spicules of this group of Sponges are held together by perishable spongin, it is extremely rare to find them in their natural positions in the fossil state, and their occurrence can only be recognised from the detached spicules. These make their first appearance in the Lower Carboniferous of Ayrshire; they occur also in the Lias of the Tyrol, and are extremely abundant in the Cretaceous strata of Britain and Germany.

30. Geodites antiquus, *Hinde*. Plate V, figs. 3, 3 *a*—3 *d*.

1883. Geodia ? antiqua, *Hinde*. Cat. Foss. Sponges, p. 208, pl. xxxviii, figs. 5, 5 *a*—5 *e*.

Detached bifid and trifid zone-spicules, with elongated, cylindrical, or sub-cylindrical shafts, and simple, short, obtusely-pointed head-rays, projecting obliquely forwards at angles between 45° and 52°. The shafts in all the spicules are incomplete, the longest fragment measures 2 mm.; they vary from ·15 to ·25 mm. in thickness. The spicular head-rays are about ·35 mm. in length. Detached acerate spicules occur in the same beds with the trifid spicules, and also in other beds in which no trifid forms have as yet been found. These acerates are fusiform, straight, or slightly curved, smooth, and pointed. Provisionally they may be regarded as belonging to the same species as the trifid forms. They vary from 2 mm. to 3·9 mm. in length and from ·1 to ·22 mm. in thickness.

Distribution.—Yoredale series: Harrogate, Richmond, Arkendale, Yorkshire; Halkin, Trelogan, Flintshire. Carboniferous Limestone: Clitheroe, Lancashire. Lower Limestone series; Low Baidland (J. Smith); Law Quarry, Dalry (J. Bennie). Upper Limestone series, Glencart, Dalry (J. R. S. Hunter, J. Smith).

31. Geodites deformis, *Hinde*, sp. nov. Plate V, figs. 4, 4 *a*—4 *g*.

This species includes very robust bifid and trifid zone-spicules, their shafts are straight or slightly curved, thickest near the summits, where they are slightly compressed; below the summits the shafts are circular in transverse sections. In several specimens the head of the shaft extends slightly beyond the point from whence the head-rays are given off (Plate V, 4 *f*), and there is usually a small central depression at the top of it. The spicular rays are relatively short, stout, conical, and obtusely pointed; they project obliquely forwards at angles varying between 45° and 70°. In the bifid spicules the head of the shaft is usually compressed and the rays are opposite to each other. The rays in the same spicule are apparently inequal in length; they range from ·7 to 1·4 mm. in length by ·4 mm. in thickness near their bases. The shafts in all the specimens yet discovered are broken and incomplete; they vary in thickness from ·6 to 1·05 mm.

Accompanying the bifid and trifid spicules are unusually robust, slightly curved, sub-cylindrical or fusiform spicules, with apparently rounded extremities,

which I regard as belonging to the same species. These spicules range from 2·5 mm. to 13 mm. in length, and from ·2 to 1 mm. in thickness.

At the time of writing the 'Cat. Fos. Sponges,' I had only seen two of the bifid zone-spicules, which I then thought might be distinct from *Geodia ? antiqua;* the specimens which I have since received from Mr. John Smith confirm this opinion. The relatively large proportions and the general characters of these spicules readily distinguish them from any others of this sub-order, whether fossil or recent. The spicules are siliceous, and in the same condition of preservation as those of *Hyalostelia* with which they occur.

Distribution.—Carboniferous: Upper part of Lower Limestone series, Law Quarry, Dalry, Ayrshire (J. Smith, J. Bennie).

32. Geodites hastatus, *Hinde*, sp. nov. Plate IX, figs. 11, 11 *a*, *b*.

The distinctive zone-spicule of this species has a straight, gradually tapering shaft, and simple head-rays directed obliquely forwards at an angle of between 25° and 30° with the shaft. Associated in the same bed with the trifid spicules are numerous, more or less curved, acerate spicules, from 1·2 to 2 mm. in length, and from ·07 to ·15 mm. in thickness, which may be regarded as belonging to the same species. The head-rays of the trifid spicule are conical and pointed; they are ·25 mm. in length and nearly ·1 mm. wide at the base.

The disposition of the rays of the trifid spicule readily distinguish it from those of *G. antiquus;* it is also smaller, and the acerate spicules are likewise smaller than in the allied form.

These spicules are now of chalcedonic silica; they occur in thin layers of calcareous shale between massive beds of limestone. By dissolving the shale in acid they are obtained free from the matrix.

Distribution.—Carboniferous Limestone: Clitheroe, Lancashire.

33. Geodites cornutus, *Hinde*, sp. nov. Plate IX, figs. 12, 12 *a*—12 *e*.

The zone-spicule in this species has a straight, slender, gradually tapering shaft and simple head-rays, which spring nearly at right angles from the top of the shaft and curve backwards. This zone-spicule is accompanied by straight or slightly-curved, fusiform, acerate spicules from ·8 to 1·3 mm. in length, and from ·05 to ·07 mm. in thickness. In an adjoining locality a slender anchor-spicule

occurs, it has a conical head and simple rays directed backwards; the shaft is imperfect. This anchor is intermingled with acerate spicules similar to those occurring with the zone-spicule.

With the same forms of acerate spicules at Richmond, there are present one or two examples of kidney-shaped spicules similar to those of the dermal layer of the existing *Geodia.* They vary from ·13 to ·2 mm. in diameter. It is very doubtful if these really belong to the same Sponge as the zone, anchor, and acerate spicules, and they are but provisionally placed with them. These dermal spicules have not previously been found so low as the Carboniferous Rocks.

Distribution.—Yoredale series: Henblas, Trelogan, Flintshire; Richmond, Yorkshire.

34. Geodites simplex, *Hinde*, sp. nov. Plate IV, fig. 3.

1880. Acerate spicule of unknown Sponge, *Carter.* Ann. and Mag. Nat. Hist., ser. 5, vol. vi, p. 212, pl. xiv, fig. 15.

Straight or curved acerate fusiform spicules, gradually tapering from the centre to acutely pointed extremities. They vary from ·55 to 1·4 mm. in length, and about ·1 mm. in thickness. No trifid or zone-spicules have as yet been found in the same beds with these acerates; but, judging by their form and proportions, it seems probable that they belong to a Sponge of this genus, and they are provisionally included in it for convenience of reference. Some of the forms were obtained by Mr. J. Wright from decayed chert, whilst others were found in a small hollow in a block of chert.

Distribution.—Carboniferous; Upper Limestone series, Ben Bulben, Sligo. Yoredale (?) series, Gwydfyd, Great Orme's Head, North Wales.

Genus—Pachastrella, *O. Schmidt.*

1868. Die Spongien der Küste von Algier, p. 15.

Syn.—Battersbya, *Bowerbank;* Dercitus, *Gray.*

Generic Characters.—Massive, nodose, platter-shaped, or irregularly expanded Sponges, without specialised dermal layer, frequently attached to and incrusting other Sponges. No special canals shown in fossil examples. The skeleton consists

mainly of four-rayed spicules, mingled loosely together without definite arrangement; acerate spicules are also present. The rays of the tetractinellid spicules may be either simple or furcate, equal or unequal in length; one ray may be developed so as to form an approximate shaft, or it may be reduced to a blunted knob or even disappear altogether. In some instances also, one ray is prolonged beyond the central point of junction, so that the spicule becomes five-rayed.

As the skeletal spicules in this genus are originally only held together by the soft perishable spongin, entire Sponges are of rare occurrence in the fossil state, and they have as yet only been met with in the Upper Chalk of Yorkshire and Germany. Detached spicules are, however, very abundant and widely distributed. They first appear in the Carboniferous strata of Ayrshire, and they also occur in the Lias, the Lower and Upper Greensand, the Chalk, and in the Eocene Tertiary. Throughout this series of rocks the spicules exhibit the same general characters as those of existing species of the genus.

35. Pachastrella vetusta, *Hinde*. Plate V, figs. 5, 5 *a*—5 *c*.

1883. Pachastrella vetusta, *Hinde*. Cat. Foss. Sponges, p. 209, pl. xxxviii, figs. 6, 6 *a*—6 *f*.

This species includes detached spicules of the normal four-rayed type, also spicules in which three or five rays are present. In the four-rayed spicules, three of the rays are nearly in the same plane, or form the outlines of a low, three-sided pyramid, whilst the fourth, or vertical ray, is usually shorter than the others. In some spicules the vertical ray is absent, whilst in others it is prolonged beyond the junction with the three rays, and the spicule is then five-rayed. The rays are straight or slightly curved, cylindrical or gradually tapering from the centre to the obtusely-pointed extremity; occasionally the ends are digitate. As a rule the rays in the same spicule are unequal in length. In a small specimen the rays are only ·54 mm. long by ·16 mm. in thickness, whilst in a single large specimen they measure 6 mm. by ·85 mm.

These spicules are of somewhat rare occurrence in the Dalry decayed chert, in association with the detached spicules of *Hyalostelia*, and they are in the same mineral condition as these latter. A few imperfect specimens, having the same characters as those from Dalry, but of much smaller proportions, are present in calcareous shale at Clitheroe.

Distribution.—Carboniferous: Upper part of Lower Limestone series, Cunningham Baidland, Law Quarry, Dalry, Ayrshire (J. Smith, J. Bennie). Carboniferous Limestone: Clitheroe, Lancashire.

36. PACHASTRELLA HUMILIS, *Hinde*. Plate IV, fig. 7.

1880. QUADRIRADIATE SPICULE, *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. vi, p. 212, pl. xiv, fig. 17.

This name is proposed for detached four-rayed spicules of the normal type. The rays are simple, three of them are subequal in the same spicule, whilst the fourth or vertical ray is apparently shorter than the others. The rays are about ·3 mm. in length by ·07 mm. in thickness. These are more regular in form besides being distinctly smaller than those placed under *P. vetusta*, and they appear to indicate a distinct species. They are of rare occurrence in the decayed chert of Ben Bulben, and specimens in a fragmentary condition are present in the Sponge-beds at Halkin. In both these localities they are siliceous, and in the same mineral condition as the hexactinellid spicules intermingled with them.

Distribution.—Upper Limestones: Ben Bulben, Sligo (J. Wright). Yoredale Series: Henblas, Flintshire.

Sub-Order.—LITHISTIDÆ.

Family.—RHIZOMORINA.

Genus.—CNEMIDIASTRUM, *Zittel*.

1878. Studien über fossile Spongien. Zweite Abth. Abhandl. d. k. bayer. Akademie der Wissenschaften, Cl. ii, Bd. xiii, Abth. 1, p. 109.

Syn.—Cnemidium (in part); Achilleum (in part), *Goldfuss, Quenstedt;* Cnemispongia, *Quenstedt;* Cupulospongia (in part), *D'Orbigny;* Cnemiopelta, Cnemipsechia, Pachypsechia, ? Ceriopelta, Trachycinclis, *Pomel*.

Generic Characters.—Sponges for the most part simple, rarely compound, conical, cylindrical, turbinate, and vasiform, with thick walls and deep cloacal cavity. The walls are traversed by numerous vertical fissures, which towards the exterior bifurcate and anastomose with each other. These fissures consist of canals placed directly over one another and separated from each other by thin partitions of the spicular skeleton. A smooth dermal layer extends over both the outer and inner surface of the Sponge-wall, and the canal-apertures either project slightly above this layer or are in shallow depressions below it. The skeleton consists of moderately large spicules of curved irregular forms, branching at the

ends, and throughout covered with spinous projections, which frequently terminate in minute facets.

The examples of this genus have hitherto only been known from the Jurassic strata of Germany and Switzerland, but in the Carboniferous Limestones of Ireland, detached skeletal-spicules are present, which so closely resemble those of the typical forms of the genus that they may provisionally be referred to it.

37. Cnemidiastrum priscum, *Hinde*, sp. nov. Plate V, figs. 6, 6 *a*—6 *f*.

1880. Lithistid (dendritically branched surface spicule), *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. vi, p. 212, pl. xiv b, fig. 12.

This name is proposed for detached spicules of irregular forms, either curved, or variously branching, and terminating in small twig-like extensions. Minute spinous processes with facetted ends project from the surface of the spicules. The spicules vary from ·5 to ·8 mm. in length, and from ·075 to ·2 mm. in thickness.

These spicules are of not infrequent occurrence in the beds of decayed Carboniferous chert at Ben Bulben, associated with the spicules of *Spiractinella* and other hexactinellid and lithistid Sponges. As a rule they are quite detached from each other, but fragments of the skeleton occur in which two or three of the spicules are united together by the apposition of their spinous processes in the same manner as in the Jurassic examples of the genus.

Distribution.—Carboniferous Limestone: Ben Bulben, near Sligo, Ireland (J. Wright).

Family.—Megamorina.

Genus.—Doryderma, *Zittel.*

1878. Studien über fossile Spongien. Zweite Abth. Abhandl. d. k. bayer. Akademie der Wissenschaften, Cl. ii, Bd. xiii, Abth. 1, p. 131.

Syn.—Spongia (in part), *Mantell, Phillips;* Spongites (in part), *Mantell;* Polyjerea (in part), *Roemer, Quenstedt;* Polypothecia (in part), *Benett.*

Generic Characters.—Sponges either simple or compound; cylindrical, pear-shaped, or dendriform, with cylindrical branches. The main body of the Sponge (and also the branches when present) is traversed longitudinally by parallel tubes

or canals opening at the truncated summit. Smaller canals extend radially from the surface towards the central axis. The skeleton is composed of relatively large, irregularly branching, spicules of great variety of form. The spicular branches are usually curved, simple, or bifurcated, and they either taper to an obtuse point or possess a flattened or slightly hollow facet at the extremity. These spicules are united either by the interlocking of the tapering branches, or by the close adpression of their facetted extremities to the rays of adjoining spicules, so as to form a somewhat coarse, open, irregular meshwork. The dermal layer consists of slender trifid spicules with elongated shafts, and small, simple, or compound head-rays. The shafts of these spicules are inserted in the mesh-apertures on the surface of the Sponge, whilst their head-rays slightly project outwards. Rarely, however, are the dermal spicules preserved *in situ*.

This genus makes its first appearance in the Carboniferous Rocks of Ayrshire, in which the characteristic skeletal spicules are found, but hitherto no entire Sponge; in the Lower and Upper Greensand and the Chalk the genus is abundantly represented.

38. Doryderma Dalryense, *Hinde*. Plate V, figs. 7, 7 *a*—7 *c*.

1883. Doryderma Dalryense (in part), *Hinde*. Cat. Foss. Sponges, p. 210, pl. xxxviii, figs. 7, 7 *a*—7 *d*; cet. excl.

The detached skeletal-spicules included in this species are more or less curved and irregularly branching, the branches are cylindrical in section and generally possess an elongate, concave, terminal expansion; in some examples the branches taper to an obtuse point. A fairly average spicule is 1 mm. in length and ·18 mm. in thickness.

These spicules are of rare occurrence in the same deposits in Ayrshire in which the detached spicules of *Hyalostelia* and other genera are abundant. In my original description of this species I included in it some smaller spicules from Ben Bulben, Sligo, but on further study I believe them to be quite distinct.

Distribution.—Carboniferous: Upper part of Lower Limestone series; Law Quarry, Dalry (J. Bennie). Upper Limestone series; Monkcastle, Kilwinning, Ayrshire (J. Smith).

Family.—ANOMOCLADINA.

Genus.—HINDIA, *Duncan.*

39. HINDIA PUMILA, *Hinde*, sp. nov. Plate V, figs. 8, 8 *a*—8 *f*.

1880. LITHISTID (? Tripod-like surface spicule of unknown species), *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. vi, pl. xiv B, figs. 10, 11.
1883. DORYDERMA DALRYENSE (in part), *Hinde*. Cat. Foss. Sponges, p. 210, pl. xxxviii, figs. 7 *e*—7 *g*.

Entire Sponge unknown, the skeletal-spicules included in the species are, for the most part, tripodal in form, with a compressed triangular central node, from which three, short, cylindrical, straight or curved rays are given off. The rays terminate in flattened or concave, circular or ovate expansions. In some instances one of the rays furcates, so that the spicule consists of four rays. The central node is flattened or slightly convex above, and generally smooth and even, but in one specimen a small central wart is present. The spicular rays vary from ·2 to ·35 mm. in length by ·09 mm. in thickness.

In their peculiar tripodal form these spicules so closely resemble those of *Hindia fibrosa*, the typical species of the genus, that they may reasonably be included in it. They are, however, considerably larger than those of the type form, and further differ in the absence of the fourth or truncated ray, which in most, if not in all the spicules of *Hindia fibrosa*, projects upwards from the centre of the spicular node. It is possible that even in this latter species the fourth ray may be in some instances altogether suppressed, and its absence in these Carboniferous spicules is not sufficient to exclude them from the genus.

I had previously placed these detached spicules under *Doryderma*, but after seeing a larger series of them, and comparing them with the spicules of *Hindia fibrosa*, which I have lately obtained in a similarly detached condition, it seems preferable to remove them to the present genus. The spicules occur in the decayed chert of Ben Bulben, they are siliceous and in the same state of preservation as the hexactinellid spicules with which they are associated. Fragmentary spicules allied to the Ben Bulben forms, if not identical with them, are also present in the Sponge-beds at Richmond, Yorkshire.

Distribution —Upper Limestones of the Carboniferous series ; Ben Bulben, near Sligo, Ireland (J. Wright).

Sub-Order.—HEXACTINELLIDÆ.

Group.—LYSSAKINA.

Genus.—HYALOSTELIA, *Zittel.*

40. HYALOSTELIA SMITHII, *Young and Young* sp. Plate VI, figs. 1, 1 *a*—1 *l*, 2, 2 *a*—2 *k*.

1876. ACANTHOSPONGIA SMITHII, *Young and Young.* Cat. Western-Scottish Fossils, p. 38.
1876. HYALONEMA PARALLELUM, *Young* (non *M'Coy*). Ibid., p. 38.
1877. ACANTHOSPONGIA SMITHII, *Carter.* Ann. and Mag. Nat. Hist., ser. 4, vol. xx, p. 176.
1877. HYALONEMA — (in part), *Young and Young.* Ann. and Mag. Nat. Hist., vol. xx, p. 426, pl. xiv, figs. 1—3, 5—12, 14—17; pl. xv, fig. 30.
1877. ACANTHOSPONGIA — *Zittel.* Studien, Abth. 1, p. 60.
1878. HYALONEMA PARALLELA, *R. Etheridge, jun.* Geol. Mag., new ser., vol. v, p. 119.
1878. — SMITHII (in part), *Carter.* Ann. and Mag. Nat. Hist., ser. 5, vol. i, p. 129, pl. ix, figs. 1—9, 12, 13.
1878. HYALOSTELIA — *Zittel.* Handbuch der Pal., vol. i, p. 185.
1879. HYALONEMA — *Nicholson.* Man. of Pal., vol. i, p. 145.
1880. — ? GIRVANENSE, *Nich. and Ether., jun.* Mon. Silur. Foss. Girvan, Fas. ii, p. 239, pl. xix, figs. 1—1 *b*.
1880. ACANTHOSPONGIA SMITHII, *F. Roemer.* Lethæa Pal., p. 317.
1883. HYALOSTELIA — *Hinde.* Cat. Foss. Sponges, p. 150, pl. xxxii, figs. 1, 1 *a*—1 *g*.

Entire form of Sponge unknown; the portions preserved are fragments of the dermal layer with the spicules *in situ*, detached skeletal-spicules of various forms and dimensions, and bundles of elongated, rod-like spicules, and isolated fragments, forming the anchoring appendage of the Sponge.

The dermal layer of the Sponge consists of relatively large hexactinellid spicules in which the distal ray of the vertical axis is reduced to a small rounded knob or process, or is altogether wanting, whilst the transverse rays are of unusual length, and incline downwards from the central node (Pl. VI, fig. 1 *a*). These spicules are disposed so that their transverse rays overlap each other, and thus form quadrate interspaces which are partially filled by smaller spicules, whilst the

proximal ray of the vertical axis penetrated into the interior of the Sponge (Pl. VI, fig. 1).

The spicules of the body of the Sponge are regular and modified hexactinellids. In the simplest form, the rays are straight and gradually taper from the central node to an obtuse point; the vertical axis is also considerably longer than the transverse axes of the spicule. In other spicules the rays are very unequally developed, and sometimes curved. In some, probably abnormal, forms, five of the rays are reduced to small knobs. In other spicules the distal ray is not developed. There are great variations in the dimensions of the skeletal- and dermal-spicules. In small examples the principal axis is ·64 mm. in length by ·1 mm. in thickness, whilst the main axis in large forms attains to 9 mm. in length by ·54 mm. in thickness.

The spicular rods belonging to the anchoring appendage of the Sponge, occur either in detached fragments, or as broad compressed bands, in which the component rods are parallel to, and in contact with, each other. The rods are smooth, cylindrical, and with a well-developed axial canal, and not infrequently show traces of the concentric layers of which they are composed. In some, if not in all cases, the rods terminate in four short, blunted, more or less recurved rays (Pl. VI, figs. 2 *e*—2 *k*). No complete bundle of rods has been discovered; Messrs. Young have traced them to a length of 300 mm. (12 inches). The longest fragment which has come under my notice has a length of 170 mm. by 38 mm. in width, and from 5 to 10 mm. in thickness. There is also great variation in the size of the rods in the same bundle; the majority vary from ·95 to 1·35 mm. in diameter, but there are smaller ones intermingled, which are not more than ·15 mm. in thickness.

The skeletal-spicules of this species occur for the most part independently detached from each other, and mingled with spicules of other kinds of Sponges in beds of decayed chert in the Lower Carboniferous strata of Scotland, Yorkshire, North Wales, and Ireland. They also occur in close association with the ropes or bundles of anchoring-spicules, but not infrequently these latter are met with in beds which do not apparently contain the hexactinellid skeletal-spicules. This fact, however, may be explained by the greater chance of preservation of the anchoring-spicules owing to their penetration in the bottom ooze during the existence of the Sponge. It may be assumed that the anchoring and the skeletal-spicules belong to the same species. Further, the small fragments of the dermal layer of the Sponge which have been met with afford a clue to the character of the skeletal-spicules of the species, since they consist exclusively of simple and modified hexactinellids, and thus justify excluding therefrom those peculiar forms which were originally supposed to belong to this same species.

The spicules of this species in the decayed cherts and limestones of the West of Scotland are of a porcelain-white tint, the larger forms are opaque, but the smaller,

when mounted in Canada balsam, are translucent, and in some instances quite transparent. They are all siliceous, and the silica is either chalcedonic or crystalline. As a rule the axial canals are abnormally enlarged; in some cases the wall of the spicule is reduced to a thin crust inclosing the canal, and even this is occasionally destroyed, and merely the solid infilling of the canal remains. The anchoring-rods have precisely the same appearance, and are in the same state of preservation as the skeletal-spicules. The anchoring-spicules occurring in the Yoredale rocks at Richmond, Yorkshire, have a translucent, horny aspect; they consist of chalcedonic silica.

This species is very abundant and widely distributed in the Lower Carboniferous of Scotland, and in the cherts and limestones of the Yoredale series of Yorkshire. In some places beds of rock, six inches (·015 m.) in thickness, are made up of bands of the anchoring-spicules crossing over each other in a generally horizontal direction, and it is probable that many of the Sponge-beds, mentioned in the Introduction, principally consist of the detached spicules of this species. As already mentioned, some of the anchoring-spicules are met with in the Ordovician strata of Girvan, Ayrshire. This species may be distinguished from *Hyalostelia parallela*, M'Coy sp., by the much more robust character of the spicular rods.

Distribution.—Carboniferous, Yoredale series: Yorkshire,—Richmond, Arkendale, near Muker; Gunnerside Gill, Swinner Gill, Sargill Beck, and throughout Swaledale generally, where the main chert crops out. Flintshire,—Halkin, Henblas, near Holywell.

Scotland.—Upper part of Lower Limestone series: Cunningham Baidland, Low Baidland, Auchenskeith, Thirdpart, Hourat, Law, Birkhead, Blackstone, Dalry. Upper Limestone series: Linn Spout, Glencart, Lambridden, Dalry, Ayrshire; Gateside, Beith; Brockley, Lesmahagow; Ponniel Water, Douglas. Messrs Young cite also the following localities: Dockra, Hillhead and Trearne quarries, near Beith; Waterland Quarry, Dunlop, Ayrshire; Corrieburn, Campsie Hills, Bathgate, Chapel Quarry, near Kirkaldy, Fifeshire. Mr. R. Etheridge, junr., also records this species from Petershill and Galabraes quarries, near Bathgate; Tartraven old quarry, near Linlithgow; Charlestown Quarry, near Inverkeithing; Roscobie Quarry, near Dunfermline; Laddedie Quarry, near Cupar; Airfield, near Cousland, by Dalkeith.

Ireland.—Calp series: Bundoran, Co. Leitrim, Tyrone. Upper Limestone series: Ben Bulben, near Sligo.

41. Hyalostelia parallela, *M'Coy* sp. Plate VI, figs. 3, 3 *a*—3 *g*.

1844. Serpula parallela, *M'Coy*. Synop. Carb. Foss. Ireland, p. 169, pl. xxiii, fig. 30.
1843. — socialis, *Portlock* (non *Goldfuss*). Geol. Report Londonderry, p. 362, pl. xxv a, figs. 9 *a*, 9 *b*.
1854. — parallela, *Morris*. Cat. Brit. Foss., p. 92.
1866. Hyalonema parallelum, *Suess*. Ann. and Mag. Nat. Hist., ser. 3, vol. xviii, p. 404.
1878. — Youngi ?, *R. Etheridge, jun.* Geol. Mag., vol. v, p. 119.
1880. Acestra parallela, *F. Roemer*. Lethæa Pal., p. 318, fig. 60.
1880. Sarcohexactinellid, *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. vi, p. 211, pl. xiv b, figs. 8, 9.
1881. Acestra parallela, *Nathorst*. Om spår af några evertebrade djûr., Kong. Svenska. vetensk. Akad. Handl., Bd. 18, No. 7, p. 46.
1883. Hyalostelia — *Hinde*. Cat. Foss. Sponges, p. 151.

This species includes simple and modified hexactinellid spicules, probably belonging to the body-skeleton and the dermal layer, together with fragments of the spicular bundles, and detached rod-like spicules, forming the anchoring appendages of the Sponge. In the spicules of the dermal layer only five rays are present, the distal ray not being developed. The transverse rays are straight or slightly curved, nearly cylindrical, or but slightly tapering, and terminate obtusely. The rays vary from ·45 to 1·5 mm. in length, and from ·1 to ·25 in thickness. The spicules are siliceous, and in some specimens the canals are preserved.

The elongated spicular rods of the anchoring-rope of the Sponge have smooth, even surfaces, and appear to be cylindrical. Near the distal ends they slightly expand, and they terminate in conical extremities with four short, stout, recurved points or rays. The canals in these spicular rods are usually preserved, and in some instances the concentric layers can be seen (Pl. VI, fig. 3 *f*). As a rule they are now of chalcedonic silica, but in some cases the silica has been replaced by calcite. The anchoring-spicules sometimes occur detached from each other, and widely spread out on the surface of the rock; not unfrequently they are grouped into compressed bundles of 5 to 9 mm. in width, in which the component spicules are nearly in contact and disposed parallel to each other. Fragments of these bundles or ropes occur, having a length of 140 mm. The individual rods in the same bundle exhibit considerable variation in size; they range from ·05 to ·5 mm. in thickness.

This species was originally proposed by Portlock for narrow bands or bundles of

the anchoring-spicules on a slab of dark limestone, which he regarded as identical with the groups of annelid tubes described by Goldfuss as *Serpula socialis.* Subsequently M'Coy disputed the identity of the specimens with Goldfuss's species; but, accepting their annelidan characters, changed the name to *Serpula parallela.* Professor Suess of Vienna appears to have first called attention to the real character of the spicular bundles, by comparing them to the anchoring-ropes of the recent *Hyalonema.*

Hitherto only the bands of anchoring spicules have been included in this species, but I have discovered on the slab of limestone containing Portlock's typical anchoring-spicules, a single modified hexactinellid spicule of the same character as those discovered by Mr. J. Wright, associated with the anchoring-spicules in the decayed chert of Ben Bulben; and there seems, therefore, good reason to suppose that these five-rayed dermal spicules belong to the same Sponge as the anchoring-spicules.

This species differs from *Hyalostelia Smithii,* not only in the form of the dermal spicules, but the anchoring-spicules are considerably smaller. Whilst in *H. Smithii* the majority of the spicules range from ·7 to 1·4 mm. in thickness, in the present species they seldom exceed ·5 mm. in thickness. They closely correspond in size with *H. fasciculus,* M'Coy sp., but in no instance have I seen any of the transverse rods or frills which characterise this latter species.

Distribution.—Carboniferous Limestone: Clitheroe, Lancashire; Yoredale series, Gunnerside Gill, Muker, Richmond, Yorkshire; Henblas, Gwydfyd, Great Ormes' Head, North Wales.

Scotland.—Beith, Ayrshire; Hillhead and Whitfield quarries, near Macbiehill Station, Peebles; shale above No. 1 Limestone (R. Etheridge, junr.).

Ireland.—Calp or Middle Limestones: Ballinhillick, Bundoran, Co. Leitrim; Clogher, Tyrone. Upper Limestones: Ben Bulben, near Sligo.

Genus.—Holasterella, *Carter,* emend. *Hinde.*

1879. Ann. and Mag. Nat. Hist., ser. 5, vol. iii, p. 141.

Generic Characters.—Massive club-shaped Sponges, supported on a sub-cylindrical stem. The body of the Sponge apparently traversed longitudinally by sinuous canals. The skeleton consists of comparatively large, regular, hexactinellid and other spicules, mingled with smaller stellate and globostellate forms. The larger spicules are disposed irregularly; some of their rays appear to be partially fused with those of adjoining spicules, probably resulting from fossilization, whilst

the stellate spicules fill the interspaces between the rays of the larger; they also line the canals, and apparently cover the surface of the Sponge.

Mr. Carter did not give a diagnosis of this genus apart from the characters of the typical species *H. conferta*. I have prepared that given above from a study of the type specimen described by Mr. Carter, and now in the possession of Mr. J. Thomson of Glasgow; and Mr. Carter kindly supplied me with some detached fragments from it.

The type-specimen is in a very unfavorable condition of preservation, and the characters of many of its component spicules cannot be ascertained with certainty. The larger spicules are so fused and intermingled together that no complete forms are exposed to view; there is no doubt, however, that some are normal hexactinellid spicules, with smooth, tapering rays, whilst others, judging from fragments, are peculiar forms with curved and spinous rays. The minute stellate spicules of the surface, and lining the canals of the Sponge, have from six to fifteen rays radiating from a thickened centre. It seems highly probable that the stellates with more than six rays may be merely modified hexactinellid spicules in which furcation has taken place in one or more of the normal rays. Owing to their small size, and their present condition, the central portion of these spicules is not clearly shown.

The *larger* spicules, which Mr. Carter has described and figured as belonging to the type specimen, were not obtained from it, but they were detached spicules, and it is uncertain if they were derived from the same locality as the Sponge itself. Mr. Carter regarded these detached spicules (*l. c.*, pl. xxi, figs. 4, 5, 7) as identical with those forming the interior portion of the skeleton of the Sponge, but after careful examination of the original specimen, I am unable to agree with this conclusion. The larger spicules in it are to a large extent concealed and obliterated; but, judging from the portions remaining, they appear to me to be quite distinct from the "double stelliform nail-like spicules," originally figured by Mr. Carter as doubtfully belonging to *Hyalonema Smithii* ('Ann. and Mag. Nat. Hist.,' ser. 5, vol. i, p. 133, pl. ix, fig. 11).

As this genus is, in part at least, composed of normal hexactinellid spicules, its systematic position appears to me to be in the Lyssakine group of the Hexactinellidæ. Mr. Carter, however, regards it as the type of a new group, 'Holasterellina,' among the Suberitida, thus belonging to his Holorhaphidota (= Monactinellidæ).

Only the typical species *H. conferta* can, in my opinion, properly be included in the genus; the other species which by Mr. Carter and myself (before that I had seen the original specimen) have been referred to it, I propose to place in distinct genera.

42. Holasterella conferta, *Carter*. Plate VIII, figs. 2, 2 *a*—2 *g*.

1879. Holasterella conferta, *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. iii, p. 141, pl. xxi, figs. 1, 2, 8, cet. excl.
1883. *Non* — — *Hinde*. Cat. Foss. Sponges, p. 152, pl. xxxii, figs. 2—2 *f*.

The typical example of the species is a club-shaped Sponge, about 165 mm. in height by 50 mm. in extreme width. It gradually increases in thickness from its base to the rounded summit. The Sponge is broken into several pieces, and its form is to such an extent enveloped and concealed by the matrix, that I have not attempted to figure its outline.

The canals which apparently traverse the Sponge longitudinally are sinuous in their course, and from ·5 to ·8 mm. in width. The surface of the Sponge is also excavated by numerous ovoid or wedge-shaped pits from 1 to 1·5 mm. in length; some of these extend but a short distance into the Sponge, and exhibit smooth sides. They are regarded by Mr. Carter as the burrows of crustaceans.

The minute stellate and globo-stellate spicules occur in small groups on the surface, and in the interior of the Sponge; their rays terminate obtusely. They have an average diameter, including the rays, of ·3 mm. The rays of the smaller hexactinellid spicules, which partly compose the body of the Sponge, are about ·3 mm. in length; whilst in some of the larger spicules, which are only partially shown, the rays reach to 2·3 mm. in length by ·3 mm. in thickness. The spicules and fragments figured on Pl. VIII, figs. 2—2 *g* are drawn from the type-specimens forwarded to me by Mr. J. Thomson and by Mr. Carter, and they are the most perfect which could be found in them.

Distribution.—Carboniferous: highest beds of Upper Limestone of the South-west of Scotland, near Glasgow (J. Thomson).

Genus.[1]—Spiractinella, *Hinde*, gen. nov.

Syn.—Holasterella (in part), *Carter*, *Hinde*.

Form of Sponge unknown, it is composed of simple hexactinellid spicules, and forms derived from them, which apparently were quite free from each other, and merely held in position by the soft structures of the Sponge. The simple hexac-

[1] Σπείρα, anything wound round; ἀκτίν, ray, dimin.

tinellid spicules have tapering, pointed rays; in the modified compound forms the rays are once, or oftener furcate, so that in certain examples they resemble stellate spicules. The surface of the rays of both the larger and smaller spicules consists of a spiral ridge extending from their bases to their tips. In the bases of the larger spicular rays the ridge is broken up into a series of ellipsoidal nodes.

I propose this genus to include the forms placed by Mr. H. J. Carter, F.R.S., in *Holasterella Wrightii.* The spicules so markedly differ from those of the type form of *Holasterella*, as far as these latter can be ascertained, that they may be regarded as belonging to a distinct genus. In the simplest spicules there are six straight, pointed rays at right angles to each other, and their surfaces are ornamented with a continuous spiral ridge or coil; in some of the compound forms the rays bifurcate equally near their bases, and the spicules then consist of twelve sub-equal rays. Most of the larger spicules are of this type. In the more complex stellate spicules the primary six rays appear to be always present, but they divide and sub-divide near their bases somewhat irregularly, so that from each primary ray three, four, five, and even six rays are given off in such a manner that the spicule has a star-like form, and consists of a variable number of rays, ranging from twelve to thirty-six.

The spicules of this genus are characterised not only by their spiral coil, but by the furcation of the rays of the larger skeletal-spicules as well as of the smaller stellates. Only a single species is at present known, and this was discovered by Mr. J. Wright, F.G.S., in decayed chert of Carboniferous age.

43. Spiractinella Wrightii, *Carter* sp. Plate VIII, figs. 1, 1 *a*—1 *h*.

1880. Holasterella Wrightii, *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. vi, pl. xiv b, figs. 1—7.
1883. — — *Hinde*. Cat. Foss. Sponges, p. 153, pl. xxxii, figs. 4—4*f*.

The character of the spicules has already been stated in the definition of the genus. In the larger spicules the rays do not appear to divide more than once, they diverge from each other near the base of the simple ray at an angle between 70° and 80°. No complete large spicule has yet been met with; judging from imperfect specimens all the rays appear to have been furcate. The secondary rays of these larger spicules attain in some cases a length of 2 mm. by ·5 mm. in thickness. The spicules with six simple rays appear to be all of intermediate size, in these the vertical axis is usually longer and more tapering than the transverse axes; in an average form the longer axis measures 1·2 mm. by ·15 mm. in thickness. The

so-called stellate spicules are all of small dimensions, they vary from ·3 to ·67 mm. in diameter. In some the primary six rays simply bifurcate, in others one or more of the primary rays give off at their bases three or even four secondary rays, and these may also subdivide. The smaller rays of these stellates seem to have all originally possessed a spiral coil in the same manner as the larger, though it is now scarcely perceptible.

These various forms of spicules were met with quite detached from each other in a bed of decayed chert, but there can hardly remain a doubt that they belonged to the same species. The spicules are now of chalcedonic and crystalline silica, they are of a creamy-white tint by reflected light, and translucent when examined in Canada balsam. Only rarely can the axial canals be detected. I am indebted to Mr. H. J. Carter, F.R.S., and to Mr. J. Wright, F.G.S., for the opportunity of studying the type-specimens.

Distribution.—Carboniferous Limestone: Upper series, Ben Bulben, near Sligo, Ireland.

Genus.—ACANTHACTINELLA,[1] *Hinde*, gen. nov.

Syn.—Holasterella (in part), *Hinde.*

Form of Sponge unknown; the skeleton consists of relatively large spicules of very varied and aberrant forms, but apparently modifications of the hexactinellid type. In the simplest form there are only four rays in one plane at right angles to each other, in others, five rays are present, whilst other forms possess six rays. The rays may be straight or curved, sub-cylindrical or compressed. They frequently bifurcate near their ends, and give off irregularly, spinous processes, so that the extreme varieties are altogether abnormal in appearance. The spicules frequently exhibit wide canals; they are now of granular silica of a brownish tint.

The spicules for which I propose this genus, differ very considerably in form and structure from any other detached Sponge-remains mingled in the same deposits with them.

In many of them the number and arrangement of the rays appear to be indefinite, and they do not exhibit any regular plan of structure. In others, however, the primary rays are disposed like those of normal hexactinellid spicules; but, owing to the irregular development of spines and the subdivision of the rays themselves, their typical character is largely masked. Further, their peculiar granular structure, and the large and often hollow interior canals, contrast very greatly with those of the other Sponge-spicules preserved with them under similar conditions, and seem

[1] ἄκανθα, a thorn; ἀκτίν, a ray, dimin.

to point to fundamental differences in their nature. These peculiar features suggested to Mr. J. Young that they might have been produced by an incrustation over other Sponge-remains; but since no other spicules yet found in these beds present the same remarkable forms, it can hardly be assumed that they have originated in this manner.

These spicules appear to belong to a single species; they have as yet only been met with in the Carboniferous deposits of Ayrshire.

44. Acanthactinella Benniei, *Hinde.* Plate VIII, figs. 4, 4 *a*—4 *i*.

1883. Holasterella Benniei, *Hinde.* Cat. Foss. Sponges, p. 153, pl. xxxii, figs. 5—5 *e*.
1877. Incrusting Sponge?, *Young and Young.* Ann. and Mag. Nat. Hist., vol. xx, p. 429, pl. xv, fig. 41.

The characters of the species have been enumerated in the description of the genus. Usually the rays bifurcate near their extremities, but not infrequently there is a tripartite division. The rays terminate obtusely. As a rule the spicules are entirely detached, but in one or two cases a fusion of the principal axes of two spicules has taken place so that they now appear as one (Pl. VIII, fig. 4 *d*). The axes of the spicules vary from 2·5 to 4 mm. in length, and the rays are from ·5 to ·9 mm. in thickness.

In my original description, this form was placed in the genus *Holasterella*, but its characters now seem to me to be at least generically distinct.

Distribution.—Carboniferous: Upper part of Lower-Limestone series, Cunningham Baidland, Low Baidland, Law, Dalry, Ayrshire. (J. Bennie, J. Smith, J. Young.)

Flesh-spicules of Hexactinellids. Plate IX, figs. 13, 13 *a*.

In microscopic sections of the chert Sponge-beds of Yorkshire, I have recently found two distinct forms of flesh-spicules, which I am at present unable to place with any of the skeletal-spicules previously described. One form (fig. 13) is a regular six-rayed spicule, the rays are sub-equal, tapering, and furnished with blunt spines projecting at right angles from their surfaces. This spicule is ·23 mm. in its longest axis, and the rays are ·02 mm. in thickness. It is present in the Yoredale-beds at Richmond.

The other spicule (fig. 13 *a*) is a six-rayed form, in which each of the principal

rays, at a short distance from the central axis, divides into three secondary pointed tapering rays. The diameter of this form is ·4 mm., and the thickness of the rays near the centre is ·04 mm. These spicules are very unfavorably preserved; they are not uncommon in a boulder of chert from the Drift at York, associated with spicules of *Reniera* and other forms like those in the chert-beds at Richmond; it is, therefore, probable that it may originally have been derived from this neighbourhood. A flesh-spicule of a nearly similar form, but of very much smaller proportions, has been figured by Dr. Bowerbank from *Euplectella aspergillum*, Owen.[1]

Sub-Order.—Heteractinellidæ.

Genus.—Tholiasterella,[2] *Hinde*, gen. nov.

Syn.—Holasterella (in part), *Hinde;* ? Hyalonema (in part), *Carter.*

Form of Sponge unknown; the skeleton consists of spicules, which, as suggested by Mr. Carter, bear a general resemblance to the handle and ribs of an umbrella. The handle or vertical ray of the spicule supports on its summit a variable number of rays which radiate from it in a generally horizontal direction. A central disc of variable proportions is formed by the union of the bases of the horizontal rays and the upper surface of this, and of the rays, may be either smooth or covered with tubercles or blunted vertical spines. In some cases spicules of an irregular form are present, in addition to the normal umbrella-spicules.

The spicules of the body of the Sponge appear to have been aggregated together without definite arrangement; they seem to have been mostly free from each other, and merely held in position by the interlacing of their rays; but in some cases the rays appear to have been partially cemented together. The outer surface or dermal layer of the Sponge consisted of a framework with irregular interspaces, formed by the intervening and partial fusion of the horizontal rays of larger and smaller " umbrella " spicules, whilst the shafts of these spicules penetrated into the interior of the Sponge.

The spicules on which this genus is based were recognised both by Messrs. J. and J. Young and by Mr. Carter, and in the 'Cat. Foss. Sponges' I described them as a species of *Holasterella*.

Since then Mr. James Bennie, Mr. John Smith, and also Mr. John Young, have supplied me not only with many fresh examples of detached spicules, but with fragments of the skeletal-structure in which the spicules are in their original

[1] 'Mon. of the Brit. Spongiadæ,' vol. i, p. 258, pl. viii, fig. 189.

[2] *θολία*, a hat to keep the sun off, a parasol; *ἀστήρ*, a star, dimin.

positions. These fragments are built up nearly exclusively of the umbrella spicules, and they thus clearly show that we are dealing with a genus of Sponges fundamentally distinct in the character of their component spicules from those of *Holasterella* and *Asteractinella*. One distinguishing feature of the genus is the continuous character of the dermal layer, the rays of the larger spicules in it being generally fused and amalgamated together. On the other hand, the number and complete forms of the detached spicules present in the same deposits with the portions of the dermal layer, indicate that the majority of the spicules forming the interior skeleton of the Sponge were only held together by the soft animal structures of the organism.

The spicules of this genus do not show any derivation from normal hexactinellid spicules. The number of the transverse or horizontal rays varies from five to nine, and as these are apparently equally developed, and radiate at equal angles from the centre, there is no room for supposing that they result from a modification of the four transverse rays of the typical hexactinellid spicule. On the other hand, the inconstancy in the number of the rays, as well as the general characters of the spicules, and their union together (in the dermal layer) separate them very decidedly from the spicules of *Astræospongia*.

The spicules of this genus are siliceous and in a similar condition of preservation as those of *Hyalostelia* and other siliceous Sponges in the same deposit.

Four species can be recognised in the Carboniferous strata of Ayrshire, and one of these also occurs in Germany. The genus does not apparently pass higher than the Carboniferous.

45. Tholiasterella Youngi, *Hinde*. Plate VII, figs. 2, 2 *a*—2 *f*.

1883. Holasterella Youngi, *Hinde*. Cat. Foss. Sponges, p. 152, pl. xxxii, figs. 3—3 *d*.
1877. Stellate spicules, *Young and Young*. Ann. and Mag. Nat. Hist., ser. 4, vol. xx, p. 420, pl. xiv, figs. 13, 19, 24, 27, 29.
1878. Hyalonema Smithii? (in part), *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. i, p. 133, pl. ix, fig. 10.
1880. Hyalostelia Smithi, *Steinmann*. Zeitschr. d. deutsch. geol. Gesell., p. 395, pl. xix, fig. 5.

The skeletal-spicules included in this species have stout, straight, conical shafts, and from five to nine transverse rays, which may be either horizontal or slightly incurved. There is a well-marked central disc to the spicules, and its upper

surface is usually covered by numerous tubercles or blunt spines, which also extend over the proximal upper portion of the rays; in some cases the summit is smooth, whilst the under or inner surface of the disc and rays is always smooth and even. The transverse rays are compressed and sub-equal, they gradually taper to a blunted extremity. The transverse rays of the dermal spicules are partially fused together. There is considerable variation in the dimensions of the spicules. A fairly large example is 4·3 mm. in width across the summit, and the individual rays are about 2 mm in length, and about ·7 mm. in width at the base. A small spicule, on the other hand, is only 1·5 mm. across the summit, and the separate rays are ·7 mm. in length by ·15 mm. in thickness. The average number of the transverse rays is seven.

This species differs from *T. gracilis* in the greater development of the central disc, the distinct conical form, and more robust character of the transverse rays of the spicules. These features are shown alike in the fragments of the dermal layer and in the detached spicules.

Distribution.—Carboniferous: Upper part of Lower-Limestone series, Law, Low Baidland; Thirdpart, Glencart, Waterland, Dalry. Lower part of Upper Limestone series, Monkcastle Glen, Kilwinning, Ayrshire. (J. Young, J. Smith, J. Bennie.)

Also in bed of dark, pyritous shale in the Carboniferous Limestone of Ratingen, near Dusseldorf. (Steinmann.)

46. Tholiasterella gracilis, *Hinde*, sp. nov. Plate VII, figs. 1, 1 *a*—1 *g*.

The spicules of this species possess an elongate shaft, a central disc of moderate dimensions, and from six to eight transverse rays. These are straight or curved, circular or elliptical in section, and they gradually taper to an obtuse point. The upper surface of the central disc is furnished with prominent blunted spines, and in the spicules of the dermal layer there are obliquely-directed spines which form notches, into which the rays of adjoining spicules are closely fitted. In some instances also the rays are notched or furcated at their extremities (Pl. VII, fig. 1 *b*).

The dermal layer, as in the preceding species, is formed by the partial fusion and interlacing of large and small spicules.

In a large spicule the entire breadth of the summit is 5 mm., and the rays at the base are ·4 mm. in thickness. The breadth of a small spicule is 1·8 mm., and the rays are ·2 mm. in thickness. The average number of the transverse rays is six.

This species is mainly distinguished from *T. Youngi* by the more elongated

and cylindrical form of the spicular rays and the less development of the central disc.

Distribution.—Carboniferous: Upper part of the Lower Limestone series, Law, Low Baidland, Dalry, Ayrshire. (J. Smith, J. Bennie.)

47. Tholiasterella compacta, *Hinde*, sp. nov. Plate VII, figs. 3, 3 *a*.

The dermal skeleton of this species is a thick, perforated plate, consisting of "umbrella-" shaped spicules, with stout conical shafts, and five or six robust, cylindrical transverse rays. These completely fuse and amalgamate with those of adjoining spicules, and they are so closely arranged that only a few small circular or oval apertures are present between the rays. The upper surface of the spicule, forming the exposed surface of the dermal layer, is thickly covered with numerous minute, blunted tubercles.

This perforated dermal layer is from 1 mm. to 1·3 mm. in thickness, whilst the entering shafts of the spicules in some instances are ·3 mm. in length. In a specimen belonging to Mr. John Smith, a portion of the internal skeleton is preserved in connection with the dermal layer. It apparently consists of relatively large spicules of an irregularly stellate form, the rays are of unequal length, conical, and often furcate at their ends. These spicules are intermingled together without definite arrangement, and the rays are frequently fused at their points of contact with adjoining spicules.

The complete fusion of the spicules of the dermal layer, and the irregular form of the skeletal-spicules, distinguish this from other species of the genus.

Distribution.—Carboniferous: Upper part of Lower-Limestone series, Cunningham Baidland, Law Quarry, Dalry, Ayrshire. (J. Bennie, J. Smith.)

48. Tholiasterella crassa, *Hinde*, sp. nov. Plate VIII, figs. 5, 5 *a*; Plate IX, figs. 2, 2 *a*—2 *b*.

Skeleton consisting of very robust "umbrella" spicules, with conical or elongate cylindrical shaft, and from five to six transverse rays. These rays are cylindrical or conical, straight or curved, horizontal or diverging irregularly from the central disc. As a rule the transverse rays are very unequally developed, some being mere conical points, whilst others in the same spicule are relatively very long. The rays are smooth, and either simple, or with stout, obliquely placed spines,

which serve as notches, in which adjoining rays are held in position. In addition to the normal-umbrella spicules there are anomalous forms consisting of five or six unequal rays diverging irregularly from a common centre. In these it is difficult to recognise either the shaft or the transverse rays of the normal spicules. The spicules are irregularly intermingled together, the smaller forms in the interspaces between the larger. At their points of contact the rays are frequently firmly fused together; this fusion is evidently of natural origin, and not produced by secondary fossilization. The connected skeleton is thus of an intricate, confused character, in which it is not always easy to trace the individual spicules.

In a large spicule a single ray is 4·6 mm. in length, and 1·3 mm. in thickness at its base; the rays of smaller forms are about 1 mm. in length.

This species is based on a fragment of the connected skeleton, in which the spicules retain their original arrangement, as well as on detached spicules. It is characterised by the relatively large size and the irregular development of the spicules. The dermal layer is not yet known. The form appears to be rare, and limited in its distribution.

Distribution.—Carboniferous. Lower part of Lower-Limestone series, Crawfield Quarry, Beith, Ayrshire (J. Young).

Genus.—ASTERACTINELLA.[1]—*Hinde*, gen. nov.

Syn.—Holasterella (in part), *Carter*, *Hinde*. Hyalonema (in part), *Young and Young*.

Form of entire Sponge unknown, the skeleton consists of relatively large spicules, in which a variable number of unequal rays radiate from a common centre in different directions. The simplest form of these spicules has a principal vertical axis, and from six to fourteen rays diverging from the centre at varying angles. In another form one ray is conspicuously larger than the others, which radiate star-like from its summit. In others the rays are subequal. The most complex form consists of a number of rays extending from a common centre in a generally horizontal direction; the proximal portion of these rays coalesces together, so that the upper surface of the spicule has the appearance of the extended corolla of a flower, whilst beneath this are three or four robust divergent rays (Pl. VIII, figs. 3 *e*, 3 *f*). Smaller spicules in which numerous simple blunt rays diverge from a centre also probably belong to this genus. These various forms of spicules appear to have been irregularly intermingled together to form the skeleton. A few fragments have been found in which the rays of adjoining spicules are now

[1] ἀστήρ, star; ἀκτίν, ray, dimin.

partially fused together, but this probably arises from the fossilization; the numerous instances in which the spicules are now entirely free seem to indicate that they were originally only held together by the soft structures of the Sponge.

The character of these spicules clearly distinguishes them from the other detached forms with which they are associated; and the occurrence of fragments of the Sponge-skeleton exclusively composed of them likewise shows that they are distinct. No trace of any derivation from the hexactinellid type is perceptible in any of these spicules; even in the simplest form more than six rays are present, and there is no indication that they may have originated from the subdivision of the rays of a normal hexactinellid spicule.

Some of the spicules included in this genus were referred by Mr. Carter to *Holasterella conferta*, and relying on his definition I likewise relegated them to the same species in the 'Cat. Foss. Sponges;' but, as already mentioned, in a subsequent examination of the type form I have been unable to discover any of these forms in it.

Two species of this genus have been recognised in the Carboniferous strata of Ayrshire.

49. Asteractinella expansa, *Hinde*, sp. nov. Plate VIII, figs. 3, 3 *a*—3 *h*.

1877. Hyalonema Smithii (in part), *Young and Young*. Ann. and Mag. Nat. Hist., ser. 4, vol. xx, pl. xiv, figs. 20, 21.
1878. — — ? (in part), *Carter*. Ann. and Mag Nat. Hist., ser. 5, vol. i, p. 133, pl. ix, fig. 11.
1879. Holasterella conferta (in part), *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. iii, p. 141, pl. xxi, figs. 4, 5, 7, cet. excl.
1883. — — *Hinde*. Cat. Foss. Sponges, p. 152, pl. xxxii, figs. 2—2*f*.

In the simpler spicules there is a prominent vertical ray, from the summit of which nine to twelve robust rays diverge at various angles; a variable number of small conical rays are also frequently present. In other spicules there is a distinct vertical axis, whilst not infrequently no distinct vertical ray or axis is present, and the spicule consists of seven to twelve rays of varying lengths in addition to several subordinate conical rays, all radiating from a common centre. The rays are straight or slightly curved, circular in transverse section, and they gradually taper to an obtuse point. The smaller central rays are sometimes divided at their tips. In a small spicule the principal rays are ·65 mm. in length and ·125 mm.

in thickness, whilst in a large one they reach a length of 3 mm. by ·6 mm. in thickness.

In the complex corolla-like spicules the number of horizontal rays varies from eighteen to thirty, they are in close contact, and apparently amalgamated laterally for about half their length, and thus form a platter-shaped central depressed disc. The upper surface of the ray is usually covered with minute conical tubercles, which in some cases have the appearance of secondary rays. The corolla-like summit of the spicule, which ranges from 1·6 to 4 mm. in breadth, is supported on three to five stout conical rays, which appear to have extended into the interior of the Sponge, whilst the expanded summits formed the surface-layer of the Sponge. In addition to the larger spicules there are also small subspherical spicules, consisting of numerous minute, obtusely-pointed, subequal rays, nearly in contact with each other.

The spicules are siliceous, and exhibit the same appearance as those of *Hyalostelia* and other siliceous Sponges in the same deposits. In no case have I been able to recognise axial canals in them.

The spicules in these species are distinguished from those of *A. tumida* by the more elongated character of the rays as well as by differences of form.

Distribution.—Carboniferous: Upper part of the Lower-Limestone series, Law, Blackstone, Waterland, Dalry, Ayrshire. (J. Smith, J. Bennie, J. Young.)

50. Asteractinella tumida, *Hinde*, sp. nov. Plate IX, figs. 1, 1 *a*—1 *g*.

The simpler spicules of this species are star-like in form, consisting of from five to nine subequal, relatively short, very stout simple conical rays, radiating from a common centre. In the more complex forms, the longer rays are supplemented by a group of small conical rays in the central portion of the spicule, which are frequently subdivided at their summits. Spicules with vertical axes are also present as well as corolla-like spicules of the same general form as in the preceding species, but with more conical rays. The spicules included in this species vary considerably in size. The star-like forms are from 2 to 3·5 mm. in diameter, and the rays are ·85 mm. in thickness at their bases. In contrast with the larger forms, the smaller spicules are only ·45 mm. in extension, and the rays are not more than ·1 mm. in thickness.

The spicules of this species are characterised by the conical robust form of their rays. In fragmentary portions of the skeleton which have been found, the larger and smaller spicules are intermingled, and their rays are partially fused together, but the greater proportion of the spicules are now quite free from each other.

Distribution.—Carboniferous : Upper part of the Lower-Limestone series, Law, Dalry. Lower part of lower-Limestone series, Crawfield, Kilbirnie. From shale above the Linn-Spout limestone at Stacklawhill, Stewarton. (J. Smith, J. Bennie.)

Order.—Calcispongiæ.

Family.—Pharetrones.

Genus.—Peronella, *Zittel.*

1878. Studien über fossile Spongien. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. ii, p. 120.

Syn.—Scyphia, Siphonia, Spongia, *Auct.*; Eudea (in part), Hippalimus (in part), *D'Orbigny;* Siphonocœlia (in part), Polycœlia (in part), Discœlia (in part), Stenocœlia, *Fromentel;* Pareudea (in part), *Etallon;* Dendrocœlia, *Laube;* Cœloconia, Dyoconia, Gymnorea, Pliocœlia, Siphonocœlia, Lœnocœlia, *Pomel;* Spongites, Dermispongia, Radicispongia, *Quenstedt.*

Sponges simple or branching from buds, the individual forms are cylindrical, with a simple tubular cloaca which extends to the base of the Sponge. The basal portion occasionally with a smooth or corrugated dermal layer, the upper portion of the Sponge usually without a special membrane over the fibres. The circulation appears to have been carried on through the irregular interspaces of the skeletal-fibres, and special canals are not indicated in the skeleton. The anastomosing fibres form an irregular meshwork; they consist of three- and four-rayed spicules, of large and moderate dimensions, which are disposed approximately in the axial centre of the fibre, and are surrounded by similar but smaller spicules. Uniaxial spicules may possibly be also present.

This genus is stated to make its first appearance in the Devonian formation, and Prof. v. Zittel has referred to it *Scyphia conoidea*, Goldfuss, and *Scyphia constricta*, Sandberger. The spicular structure of these forms has, however, not yet been recognised, and it is not until reaching Jurassic strata that we find examples of *Peronella* in which the spicular structure of the fibres has been preserved. In calcareous shales of Carboniferous age from the East of Scotland Mr. James Bennie has found detached spicules, which in form, size, and mineral structure, correspond very closely with spicules of *Peronella*, and I therefore refer them provisionally to this genus.

51. Peronella sparsa, *Hinde*, sp. nov. Pl. IX, figs. 4, 4 *a*—4 *e*.

Detached three- and four-rayed spicules, the rays may be either subequal or inequal in length, or with two equal rays and one shorter ray, so as to resemble the "sagittate spicules" of Haeckel. They are approximately equi-angular, and in the same horizontal plane. The fourth ray, when present, is at right angles to the other three rays. The rays are smooth and slightly tapering, they terminate obtusely. They vary from ·15 to ·33 mm. in length, and from ·025 to ·062 mm. in thickness.

These spicules occur in calcareous shales, associated with the fragmentary remains of other minute organisms. They are of carbonate of lime and dissolve entirely in dilute acid. They have a porcellanic-white aspect by reflected light, and become translucent in Canada balsam. Their surfaces are smooth and even, and their outlines are as well-defined as the minute perforated plates of Holothurians, present in the same beds. No canals are preserved. Very seldom are the spicules complete, one or more of the rays are usually fractured.

Since it has been definitely proved that Calcisponges are capable of preservation in the fossil state, and detached spicules are known to be present in Tertiary strata ('Quart. Journ. Geol. Soc.,' vol. xlii, 1886, p. 214), there is no reason why they should not occur in the older rocks, as well as other similarly minute and delicate calcareous organisms. I do not see any ground for supposing that these forms are replaced siliceous spicules, since siliceous spicules of similar dimensions very seldom occur detached, and when they are preserved their outlines are usually eroded and quite unlike the present forms.

Distribution.—Lower Carboniferous: Woodend, Cowdens, Fife, Scotland (J. Bennie).

BAD AND DOUBTFUL SPECIES.

The forms referred to below, from various geological horizons of the Palæozoic series of Britain, have been placed by their authors or subsequent writers in the group of Sponges. I have given in each case the reason which has induced me to exclude them from this category, based, as far as possible, on an examination of the type-specimens which have been described. In some instances it has been possible to determine the true systematic position of these fossils, whilst the characters of others are too obscure to allow of any identification, and they must be at present regarded as *incertæ sedis*. I have not thought it necessary to refer

to the different British species of *Stromatopora*, formerly regarded as Sponges, since the Monograph on these fossils by Prof. Dr. H. A. Nicholson, F.L.S., now in course of publication, shows clearly their true relationship to the Hydrozoa. The species enumerated below are placed in alphabetical order.

52. Acanthospongia Siluriensis, *M'Coy*.

1862. A Synopsis of the Silurian Fossils of Ireland, p. 67.

The typical form is described as a " lengthened oval mass, about two inches long and three quarters of an inch wide, of crowded spicula varying in length from two lines to more than half an inch. The spicula resemble the letter X in shape, four of the rays being always very distinct and disposed in that form, but there also seems to have been certainly one similar ray extending upwards and another downwards from the centre, considering the other four to be horizontal. The rays are round, tapering, pointed, smooth, and apparently hollow. They remind us much of *Xanthidium* and those allied forms, but have obviously a stronger affinity with the group in which I have placed them, although I do not think I have seen even among any of the foreign Sponges such strong, star-like spicula."

No figure accompanies the description, and from this alone it is impossible to form an idea either of the form of the spicules or of their arrangement in the Sponge. Unfortunately, the type-specimen, which was in the collection of the late Sir R. Griffith, cannot now be found. It does not appear to have reached the Natural-History Museum in Dublin, in which the greater part of Sir R. Griffith's collection is now preserved, and nothing is known of it in the collection of the Geological Survey of Ireland. No other specimen corresponding to M'Coy's description has been discovered, and therefore the genus and species must lapse, at least for the present. There can hardly be a doubt that the original was a genuine Sponge, but whether it resembled *Protospongia* or the genus which I have named *Phormosella* cannot be determined. The type-specimen was from sandstone at Cong, near Galway, Ireland.

53. Astylospongia sp. (grata, *Salter* MS.)

1873. Cat. Cambrian and Silur. Foss. Cambridge, p. 40.

The original specimen, now in the Woodwardian Museum at Cambridge, is stated to be one of the lobed Sponges, but in reality it is only a cast, exhibiting ten ridges radiating from a common raised centre. Its character is doubtful; it may be the impression of the summit vault of a crinoid.

The figure given is a very imperfect representation of the original, which is said to be from Coniston.

54. Bothroconis plana, *King.*

1850. Mon. Permian Foss., Pal. Soc., vol. iv, p. 13, pl. ii, fig. 6.

The original specimens, now in the Museum of Queen's College, Galway, consist of shallow, circular depressions on the weathered surfaces of shelly limestone. In some instances the pits are close together, whilst in others there are considerable interspaces between them. Their origin is problematical; they may be due to mere weather-erosion since the limestone was exposed. They are certainly not Sponges.

The types are from Magnesian Limestone (Permian), Tunstall Hill, Durham.

55. Cnemidium tenue, *Lonsdale.*

1839. Murchison's Silurian System, p. 694, pl. xvi bis, figs. 11, 11 *a*, 11 *b*.

The original specimen, shown on the weathered surface of a slab of Wenlock Limestone, now in the Museum of the Geological Society of London, appears to be either a small coral or a polyzoon. It is from Dudley.

56. Coscinopora placenta ? *Lonsdale* (non *Goldfuss*).

1840. Transactions Geological Soc., ser. 2, vol. v, pl. lviii, figs. 5 *a*—5 *d*.

The original belongs to the Stromatoporoid group, and is the form known subsequently under the name of *Caunopora placenta.* It occurs in the Devonian Limestone of Plymouth and Torquay.

57. Entobia antiqua, *Portlock.*

1843. Report on the Geology of Londonderry, &c., p. 360, pl. xxi, figs. 5 *a*, 5 *b*.

Judging from examples of this species now in the Museum of the Geological Survey, Jermyn Street, which correspond closely with Portlock's descriptions and

figures, and come from the same locality as the type-specimen, it is very distinctly a polyzoon belonging either to *Hippothoa* or *Stomatopora*. H. M. Fischer has also stated that it belongs to the Bryozoa ("Recherches sur les Éponges perforantes Fossiles," 'Nouv. Archiv. du Mus d'Histoire Naturelle,' 1868, p. 133). In Morris's 'Catalogue,' 1854, p. 27, it is placed with the Amorphozoa under the genus *Cliona*.

The original specimens are from strata of Caradoc age, at Desertcraight, Tyrone.

58. Favospongia Ruthveni, *Salter* (MS.).

1855. Brit. Pal. Fossils, pl. i D, figs. 9, 9 *a*.

The examples of this species are mere structureless casts of ovoid bodies, their surfaces are covered with indistinct, circular, or irregular depressions. Their true character is problematical; there is no evidence to connect them with Sponges.

The specimens thus named are from Upper-Ludlow strata at Benson Knot, near Kendal; they are now in the Museum of the Geological Society of London, and in the Jermyn Street Museum.

59. Ischadites micropora, *Salter*.

1873. Cat. Cambrian and Silur. Foss. Cambridge, p. 40.

The specimen thus named is a fragmentary cast of some organism exhibiting rows of puncta on the surface of compressed shale. It does not show any resemblance to *Ischadites* or allied forms. The original, now in the Woodwardian Museum at Cambridge, comes from Middle-Bala strata at Blaen-y-cwm, North Wales.

60. Mammillopora mammillaris, *King*.

1850. Mon. Permian Foss., Pal. Soc., vol. iv, p. 12, pl. ii, figs. 3, 4.

The type is a small rounded mass with mammillary elevations. The surface is entirely covered with very minute polygonal perforations, similar to those of the doubtful organism *Solenopora compacta*, Billings sp. (see 'Geol. Mag.,' dec. iii, vol. ii, p. 529). No other structure is shown. This is certainly not a Sponge.

From shelly limestone (Permian), Humbleton Hill. The type is in the Museum of Queen's College, Galway.

61. Palæacis cuneata, *Meek and Worthen* sp.

1860. Proc. Acad. Nat. Sciences Philadelphia, p. 448.

Examples of this species have been discovered in the Carboniferous Limestone near Henbury, Bristol ('Geol. Mag.,' 1876, dec. ii, vol. iii, p. 267). The original form was referred to the *Petrospongiæ*; in Bigsby's 'Thesaurus Devonico-Carboniferus,' p. 201, it is placed with the Amorphozoa under the name of *Sphenopoterium cuneatum*. The nature of the fossil is doubtful; it appears to me to be rather related to corals than to Sponges.

62. Protospongia diffusa, *Salter*.

1873. Cat. Cambrian and Silur. Foss. Cambridge, p. 3.

This species is based on a few scattered, rod-like, rusty markings on the surface of a fragment of black shale of Menevian age from St. David's, South Wales. It is doubtful whether the markings represent Sponge-spicules. The original specimen is in the Woodwardian Museum at Cambridge.

63. Protospongia ? flabella, *Hicks*.
64. — ? major, *Hicks*.

1871. Quart. Journ. Geol. Soc., vol. xxvii, p. 401, pl. xvi, figs. 14—19.

The typical examples of these species, now in the Woodwardian Museum at Cambridge, consist of slightly raised, sub-parallel, straight or curved lines, which are sometimes crossed by other lines at varying angles. No structure whatever is preserved. The character of these markings is doubtful, and they are too indefinite to be regarded as portions of Sponge-structure. They occur in the Harlech Grits, near St. David's, South Wales.

65. Protospongia Ludense[is], *Holl*.
66. — maculæformis, *Holl*.

1872. Geological Magazine, vol. ix, p. 350.

These two species were described by the late Dr. Holl in a foot-note to his paper on "Fossil Sponges," but the specimens were not figured. They were from

the Lower-Ludlow strata of Leintwardine, and the originals were stated to be in the Ludlow Museum, but they cannot now be found. I had been in correspondence with Dr. Holl shortly before his death respecting these types, and, acting on a suggestion made by him, I examined, by the kind permission of Prof. Boyd Dawkins, F.R.S., the Lightbody collection, now in the Museum of Owens College, Manchester, but without meeting with them. Their loss is the more to be regretted since no other specimens corresponding with Dr. Holl's descriptions have been discovered, and his species will therefore lapse. It seems to me probable that *Protospongia Ludensis* may have belonged to the genus *Dictyophyton*, and *P. maculæformis* to *Phormosella*.

67. Pulvillus Thomsonii, *Carter*.

1878. Annals and Mag. Nat. Hist., ser. 5, vol. i, p. 137, pl. x, figs. 1—6.

I am indebted to Mr. James Thomson, F.G.S., for the opportunity of examining the type forms of this new genus and species. The specimens are bi-convex or plano-convex discs with occasionally a depression on one or both surfaces. They are composed of rounded or amorphous grains of calcite, from 1 to 3 mm. each in diameter, closely aggregated together, so that in a section but little more than the partition line between the individual grains is visible. In some cases the grains are separated by rock matrix from each other. There are no traces of Sponge-fibres of any kind nor of canals. The constituent grains of calcite in part exhibit an acicular or fibrous crystalline structure, which is regarded by Mr. Carter as indicating acerate Sponge-spicules (*loc. cit.*, pl. x, fig. 4).

Further, the objects represented as "broken ends of the spicules projecting from the surface of the large excavation" in the type-specimen appear to me to be punctures in a fragment of the shell of some Brachiopod (*l. c.*, pl. x, fig. 6). The acerate spicule, figured as the staple form of a perfect spicule (*l. c.*, pl. x, fig. 5), is derived from the sandy material of the rock matrix, and there is no evidence beyond its position that it had any relation to the supposed Sponge.

These bodies in my opinion are merely nodules of inorganic origin. They are from Carboniferous Limestones at Arbigland, near Dumfries.

68. Scyphia tuberculata, *King*.

1850. Mon. Permian Foss., Pal. Soc., vol. iv, p. 12, pl. ii, figs. 1, 2.

The type-specimen, now in the Museum of Queen's College, Galway, is a fragment of a cylindrical body, with a hollow axial tube and lateral tubes partly

connecting with it. No perforations are shown in the surface tubercles. The interior structures are entirely obliterated, and the nature of the organism is altogether doubtful.

From shelly limestone (Permian) at Humbleton Hill and Dalton-le-Dale, Durham.

69. Scyphia turbinata, *Lonsdale* (non *Goldfuss*).

1840. Trans. Geol. Soc., ser. 2, vol. v, pl. lviii, fig. 9.

I have not seen the type-specimen, the only description states: "Two pyritous specimens, embedded in slate, from the vicinity of Plymouth." Judging from the figure their characters are highly problematical. They are not likely to belong to Goldfuss's species from the Upper Jura of Streitberg, in which they have been placed by Lonsdale.

70. Sphærospongia hospitalis, *Salter*.

1873. Cat. Cambrian and Silur. Foss. Cambridge, p. 40.

This species is not congeneric with *Sphærospongia tessellata*, Phill., and probably it is related to the genus *Pasceolus*, Bill., in any event it is not a Sponge. The original is from the Middle Bala Group at Onny River, Shropshire.

71. Steganodictyum Carteri, *M'Coy*.
72. Steganodictyum cornubicum, *M'Coy*.

1855. Brit. Pal. Foss., pl. ii a, figs. 1—4.

These forms, regarded by the author as Sponges, were pointed out by Salter to be the cephalic plates of a Pteraspidian fish. This conclusion was fully confirmed by Prof. Ray Lankester, who has referred them to *Cephalaspis* and *Scaphaspis* respectively ('Quart. Journ. Geol. Soc.,' vol. xxiv, p. 546). They are found in hard slates of Devonian age, at Polperro, Cornwall.

73. Tragos Binneyi, *King.*

1850. Mon. Permian Foss., Pal. Soc., vol. iv, p. 13, pl. ii, fig. 6.

The type-specimen, now in the Museum of Queen's College, Galway, shows no traces of organic structure, and appears to me to be of inorganic origin. It comes from Bradford, near Manchester.

74. Tragos semicirculare [is], *M'Coy.*

1844. Synop. Carb. Foss. Ireland, p. 196, pl. xxvii, fig. 8.

The typical, figured example of this species, now in the Museum of Science and Art, Dublin, is a fish tooth, weathered out on the surface of a slab of limestone. It comes from the Carboniferous (Upper Limestone series) of Manor Hamilton.

75. Tragos Tunstallensis, *King.*

1850. Mon. Permian Foss., Pal. Soc., vol. iv, p. 13, pl. ii, fig. 5.

The type forms included in this species show no traces of organic structure, and appear to be only small nodular secretions, in one instance enclosing a small *Murchisonia.* I am unable to distinguish the fibrous texture described by the author. The specimens, labelled apparently in Professor King's own handwriting, are now in the Museum of Queen's College, Galway. They are from Magnesian Limestone (Permian), Tunstall Hill, Durham.

76. Verticillipora ? abnormis, *Lonsdale.*

1839. Silurian System, p. 693, pl. xvi bis, figs. 10 *a*—10 *d*.

The type-specimen, now in the Museum of the Geological Society of London, is a small coral or polyzoön. Though the author placed it in a genus of reputed Sponges, he yet regarded it as a coral. It is relegated to the genus *Ceriopora,* Goldfuss, in 'Morris's Catalogue,' 2nd ed. p. 120; but in 'Siluria,' ed. 1867, it still retains the original name and is placed under the Amorphozoa (p. 509). The specimen is from Ludlow strata at Pyrton, Gloucestershire.

77. Verticillipora dubia, *M'Coy.*

1844. Synop. Carb. Foss. Ireland, p. 194, pl. xxvii, fig. 12.

This species is founded on a specimen of incrusting coral or polyzoa. It is placed in the genus *Ceriopora*, Goldfuss, in 'Morris's Cat. Brit. Foss.,' 2nd ed., p. 120.

78. Verticillopora palmata, *Salter.*

1873. Cat. Cambrian and Silur. Foss. Cambridge, p. 100.

The original specimen, now in the Woodwardian Museum at Cambridge, is palmate, with vertical bifurcating branches. The outer surface is smooth. The structure is but very imperfectly preserved, but, judging from thin microscopic sections, it appears to be either a coral or a form of the Stromatoporoidea.

The specimen is from Wenlock strata at Dudley.

79. Vioa prisca, *M'Coy.*

1855. Brit. Pal. Fossils, p. 260, pl. 1 B, figs. 1, 1 *a.*

This species is founded on straight or slightly-curved tubular borings in the shell of a *Pterinea*, which have no definite resemblance to the undoubted perforation of boring Sponges. Salter states that they are due to an annelid ('Cat. Cambrian and Silur. Foss. Cambridge,' p. 85); and their Sponge origin has likewise been called in question by M. P. Fischer ("Recherches sur les Éponges perforantes fossiles," 'Nouv. Archiv. du Mus. d'Histoire Naturelle,' 1868, p. 134).

The form is placed under the genus *Cliona* in 'Morris's Catalogue,' 1854, p. 27. The figured type, from the Upper Silurian of Malvern, is in the Woodwardian Museum, Cambridge.

TABLE I.—*List of British Palæozoic Sponges, their Stratigraphical Distribution, and the page and plate in which they are described and figured.*

Name of Genus and Species.	Reference to Page and Plate.	Cambrian.	Ordovician.	Silurian.	Devonian.	Carboniferous.	Permian.
MONACTINELLIDÆ.	PAGE						
Atractosella siluriensis, *Hinde*	123, Pl. I, figs. 6, *a—d*	...	...	×			
Reniera Carteri, *Hinde*	142, Pl. IV, figs. 5, *a—f*	...	...	...	...	×	
— scitula, *Hinde*	142, Pl. IV, fig. 4	...	...	...	...	×	
— clavata, *Hinde*	143, Pl. IX, figs. 5, *a*, *b*	...	...	...	...	×	
— virga, *Hinde*	143, Pl. IX, figs. 6, *a*, *b*	...	...	...	...	×	
— gracilis, *Hinde*	144, Pl. IX, figs. 7, *a*, *b*	...	...	...	...	×	
— Zitteli, *Počta*	144, Pl. IX, figs. 8, *a—c*	...	...	...	...	×	
— bacillum, *Hinde*	144, Pl. IX, fig 9	...	...	...	...	×	
Axinella vetusta, *Hinde*	145, Pl. IV, fig. 6	...	...	...	...	×	
— paxillus, *Hinde*	145, Pl. IX, fig. 10	...	...	...	...	×	
Haplistion Armstrongi, *Young*	147, Pl. V, figs. 1, *a*, *b*	...	...	...	...	×	
— vermiculatum, *Carter* sp.	148, Pl. V, figs. 2, *a*	...	...	...	...	×	
TETRACTINELLIDÆ.							
Geodites antiquus, *Hinde*	150, Pl. V, figs. 3, *a—d*	...	...	...	...	×	
— deformis, *Hinde*	150, Pl. V, figs. 4, *a—g*	...	...	...	...	×	
— hastatus, *Hinde*	151, Pl. IX, figs. 11, *a*, *b*	...	...	...	...	×	
— cornutus, *Hinde*	151, Pl. IX, figs. 12, *a—e*	...	...	...	...	×	
— simplex, *Hinde*	152, Pl. IV, fig. 3	...	...	...	...	×	
Pachastrella vetusta, *Hinde*	153, Pl. V, figs. 5, *a—c*	...	...	...	...	×	
— humilis, *Hinde*	154, Pl. IV, fig. 7	...	...	...	...	×	
LITHISTIDÆ.							
Astylospongia inciso-lobata, *F. Roemer*	114, Pl. II, figs. 5, *a*	...	×				
Hindia fibrosa, *F. Roemer* sp.	116, Pl. IX, figs. 3, *a—e*	...	×				
— pumila, *Hinde*	157, Pl. V, figs. 8, *a—f*	...	...	...	...	×	
Cnemidiastrum priscum, *Hinde*	155, Pl. V, figs. 6, *a—f*	...	...	...	...	×	
Doryderma Dalryense, *Hinde*	156, Pl. V, figs. 7, *a—c*	...	...	...	...	×	
HEXACTINELLIDÆ.							
Protospongia fenestrata, *Salter*	106, Pl. I, figs. 1, 1, *a*	×					
— Hicksi, *Hinde*	107, Pl. I, figs. 2, 2, *a*	×					
Hyalostelia fasciculus, *M'Coy* sp.	110, Pl. I, figs. 3, *a*, *b*	×	×				
— gracilis, *Hinde*	129, Pl. I, figs. 5, *a—e*	...	...	×			
— Smithii, *Young & Young* sp.	118, 158, Pl. I, figs. 4, *a*; Pl. VI, figs. 1, *a—l*, 2, *a—k*	...	×	...	...	×	

Name of Genus and Species.	Reference to Page and Plate.	Cambrian.	Ordovician.	Silurian.	Devonian.	Carboniferous.	Permian.
HEXACTINELLIDÆ (*continued*).	PAGE						
Hyalostelia parallela, *M'Coy* sp.	161, Pl. VI, figs. 3, *a—g*	...	...	...	...	×	
Plectoderma scitulum, *Hinde*	124, Pl. III, figs. 1, *a*, *b*	...	...	×			
Phormosella ovata, *Hinde*	125, Pl. III, figs. 2, *a*, *b*	...	...	×			
Dictyophyton Danbyi, *M'Coy* sp.	128, Pl. II, figs. 4, *a—c*	...	...	×			
Holasterella conferta, *Carter*	164, Pl. VIII, figs. 2, *a—g*	...	...	...	...	×	
Spiractinella Wrightii, *Hinde*	165, Pl. VIII, figs. 1, *a—h*	...	...	...	...	×	
Acanthactinella Benniei, *Hinde*	167, Pl. VIII, figs. 4, *a—i*	...	...	...	...	×	
Amphispongia oblonga, *Salter*	131, Pl. III, figs. 3, *a—f*	...	...	×			
Ischadites Kœnigii, *Murch.*	120, Pl. II, figs. 1, *a*, *b*	...	×	×			
— Lindstrœmi, *Hinde*	129, Pl. II, fig. 2, *a*	...	...	×			
Sphærospongia tessellata, *Phillips*	136, Pl. IV, figs. 2, *a—d*	...	...	...	×		
Receptaculites Neptuni, *Defrance*	139, Pl. II, fig. 3; Pl. IV, fig. 1	...	...	×	×		
OCTACTINELLIDÆ.							
Astræospongia patina, *F. Roemer*	134, Pl. I, figs. 7, *a—d*	...	...	×			
— Devoniensis, *Hinde*	140, Pl. IV, figs. 8, *a—e*	...	...	...	×		
HETERACTINELLIDÆ.							
Tholiasterella Youngi, *Hinde*	169, Pl. VII, figs. 2, *a—f*	...	...	...	...	×	
— gracilis, *Hinde*	170, Pl. VII, figs. 1, 1, *a—g*	...	...	...	...	×	
— compacta, *Hinde*	171, Pl. VII, figs. 3, 3, *a*	...	...	...	...	×	
— crassa, *Hinde*	171, Pl. VIII, fig. 5, *a*; Pl. IX, figs. 2, *a*, *b*	...	...	...	...	×	
Asteractinella expansa, *Hinde*	173, Pl. VIII, figs. 3, *a—h*	...	...	...	...	×	
— tumida, *Hinde*	174, Pl. IX, figs. 1, *a—g*	...	...	...	...	×	
CALCISPONGIÆ.							
Peronella sparsa, *Hinde*	176, Pl. IX, figs. 4, *a—e*	...	...	...	...	×	

Table II.—*List of Bad and Doubtful Species in Alphabetical Order.*

	Page	Cambrian.	Ordovician.	Silurian.	Devonian.	Carboniferous.	Permian.
Acanthospongia siluriensis, *Salter*	177	...	...	×			
Astylospongia grata, *Salter*, MS.	177	...	×				
Bothroconis plana, *King*	178	...	...	...	...	...	×
Cnemidium tenue, *Lonsdale*	178	...	...	×			
Coscinopora placenta, *Lonsdale*	178	...	...	...	×		
Entobia (Cliona) antiqua, *Portlock*	178	...	×				
Favospongia Ruthveni, *Salter*, MS.	179	...	...	×			
Ischadites micropora, *Salter*	179	...	×				
Mammillopora mammillaris, *King*	179	...	...	...	...	...	×
Palæacis cuneata, *Meek and Worthen* sp.	180	...	...	...	...	×	
Protospongia diffusa, *Salter*	180	×					
— ? flabella, *Hicks*	180	×					
— ? major, *Hicks*	180	×					
— ludensis, *Holl.*	180	...	...	×			
— maculæformis, *Holl*	180	...	...	×			
Pulvillus Thomsonii, *Carter*	181	...	...	...	...	×	
Scyphia tuberculata, *King*	181	...	...	...	...	...	×
— turbinata, *Lonsdale*	182	...	...	...	×		
Sphærospongia hospitalis, *Salter*	182	...	×				
Steganodictyum Carteri, *M'Coy*	182	...	...	...	×		
— cornubicum, *M'Coy*	182	...	...	...	×		
Tragos Binneyi, *King*	183	...	...	...	...	...	×
— semicirculare [is], *M'Coy*	183	...	...	...	...	×	
— Tunstallensis, *King*	183	...	...		...	...	×
Verticillopora abnormis, *Lonsdale*	183	...	...	×			
— dubia, *M'Coy*	184	...	...	...	...	×	
— palmata, *Salter*	184	...	...	×			
Vioa (Cliona) prisca, *M'Coy*	184	...	...	×			

It will be seen from the foregoing list that in all fifty species of fossil Sponges have been enumerated from the Palæozoic strata of the British area. The numbers of species of each of the principal groups of Sponges are as follows :—Monactinellidæ twelve, Tetractinellidæ seven, Lithistidæ five, Hexactinellidæ seventeen, Octactinellidæ two, Heteractinellidæ six, and Calcispongiæ one species.

From the Cambrian strata there are at present three species known, all of which are Hexactinellids : from the Ordovician five species, two of which are Lithistids and three Hexactinellids ; from the Silurian ten species, of which one belongs to the Monactinellidæ, eight are Hexactinellids, and one an Octactinellid ; from the Carboniferous thirty-three species, of which eleven are Monactinellids,

seven Tetractinellids, three Lithistids, five Hexactinellids, six Heteractinellids, and one species of Calcisponge. No Sponge has been discovered in Permian strata.

Of the total number of species, forty-three are limited to a single system; one species passes from the Cambrian to the Ordovician, two from the Ordovician to the Silurian, one from the Ordovician to the Carboniferous, and one from the Silurian to the Devonian. Two of the Carboniferous species are, so far as can be determined from the spicules, identical with forms from the Lower Cretaceous of the South of England.

Only ten out of the fifty species are known to occur beyond the British area. These forms are present at corresponding geological horizons in Scandinavia, Germany, Belgium, Russia, and North America.

Of the species hitherto included as Palæozoic Sponges, twenty-eight are removed as bad or doubtful forms.

PLATE IX.

Figs. 1, 1 *a*—1 *g* —Asteractinella tumida, *Hinde*, sp. nov.

Figs. 1, 1 *a*—1 *f*.—Various forms of skeletal-spicules. Enlarged ten diameters.

Fig. 1 *g*.—A fragment of the skeleton of the Sponge, showing the irregular arrangement of the large and smaller spicules. Enlarged twenty diameters. From the Lower Carboniferous, upper part of the Lower Limestone series at Law Quarry, Dalry, Ayrshire. The original specimens in the collections of Mr. J. Smith and Mr. Bennie.

Figs. 2 2 *a*, 2 *b*.—Tholiasterella crassa, *Hinde*, sp. nov.

Figs. 2, 2 *a*.—Fragments of the skeleton of the Sponge, showing the arrangement of the spicules and the partial welding of the rays of adjacent forms. Enlarged ten diameters.

Fig. 2 *b*.—An "umbrella"-shaped spicule in which the rays are very inequally developed. The vertical ray has been broken off. Enlarged ten diameters. From the Lower Carboniferous, lower part of Lower Limestone series at Crawfield Quarry, Beith, Ayrshire. The original specimens in the collection of Mr. John Young, F.G.S.

Figs. 3, 3 *a*—3 *e*.—Hindia fibrosa, *Roemer* sp.

Fig. 3.—Portion of a longitudinal section, showing the spicular mesh, which has been replaced by calcite. Enlarged sixty diameters.

Fig. 3 *a*.—Portion of a transverse section of the same specimen, showing the canals bounded by the spicular mesh. From limestones of Ordovician Age at Craighead, Girvan, Ayrshire.

Fig. 3 *b*.—Portion of a longitudinal section, showing the spicular mesh. The structure has been replaced by calcite, and the junction of the spicules with each other is only faintly shown. Enlarged one hundred diameters. From Silurian strata at Dalhousie, New Brunswick.

Figs. 3 *c*, 3 *d*, 3 *e*.—Three detached spicules of the Sponge. Enlarged eighty diameters. The spicules retain their siliceous structure; they are, however, much eroded by fossilization. From a specimen from Dalhousie. The original examples are in my collection.

Figs. 4, 4 *a*—4 *e*.—Peronella sparsa, *Hinde*, sp. nov.

Figs. 4, 4 *a*—4 *c*.—Detached three-rayed spicules referred to this species. Enlarged sixty diameters.

Figs. 4 *d*—4 *e*.—Smaller four-rayed spicules. Enlarged sixty diameters. From Lower Carboniferous at Woodend, Cowdens, Fife, Scotland. Collection of Mr. J. Bennie.

Figs. 5, 5 *a*, 5 *b*.—Reniera clavata, *Hinde*, sp. nov.

Detached skeletal-spicules. Enlarged sixty diameters. From the Chert Sponge-beds of the Yoredale series at Richmond, Yorkshire, and Henblas, Flintshire. My collection.

Figs. 6, 6 *a*, 6 *b*.—Reniera virga, *Hinde*, sp. nov.

Detached skeletal-spicules. Enlarged sixty diameters. From the Carboniferous Limestone at Clitheroe, Lancashire, and from the Yoredale Sponge-beds at Richmond, Yorkshire.

Figs. 7, 7 *a*—7 *b*.—Reniera gracilis, *Hinde*.

Detached skeletal-spicules. Enlarged sixty diameters. From the Sponge-beds of the Yoredale series at Richmond, Yorkshire. My collection.

Figs. 8, 8 *a*—8 *c*.—Reniera Zitteli, *Počta*.

Detached skeletal-spicules. Enlarged sixty diameters. From the Sponge-beds of the Yoredale series at Halkin and Henblas, Flintshire. My collection.

Fig. 9.—Reniera bacillum, *Hinde*, sp. nov.

Detached skeletal-spicules. Enlarged sixty diameters. From the Sponge-beds of the Yoredale series at Trelogan, Flintshire.

Fig. 10.—Axinella paxillus, *Hinde*, sp. nov.

A detached skeletal-spicule. Enlarged forty diameters. From the Carboniferous Limestone at Clitheroe, Lancashire.

Figs. 11, 11 *a*, 11 *b*.—Geodites hastatus, *Hinde*, sp. nov.

Fig. 11.—A trifid zone-spicule. Enlarged forty diameters.

Figs. 11 *a*, 11 *b*.—Two detached acerate spicules, similarly enlarged. From the Carboniferous Limestone at Clitheroe, Lancashire. My collection.

Figs. 12, 12 *a*—12 *e*.—Geodites cornutus, *Hinde*, sp. nov.

Fig. 12.—A trifid zone-spicule. Enlarged forty diameters.

Fig. 12 *a*.—A trifid so-called anchor-spicule, similarly enlarged.

Figs. 12 *b*, 12 *c*.—Two acerate skeletal-spicules, similarly enlarged.

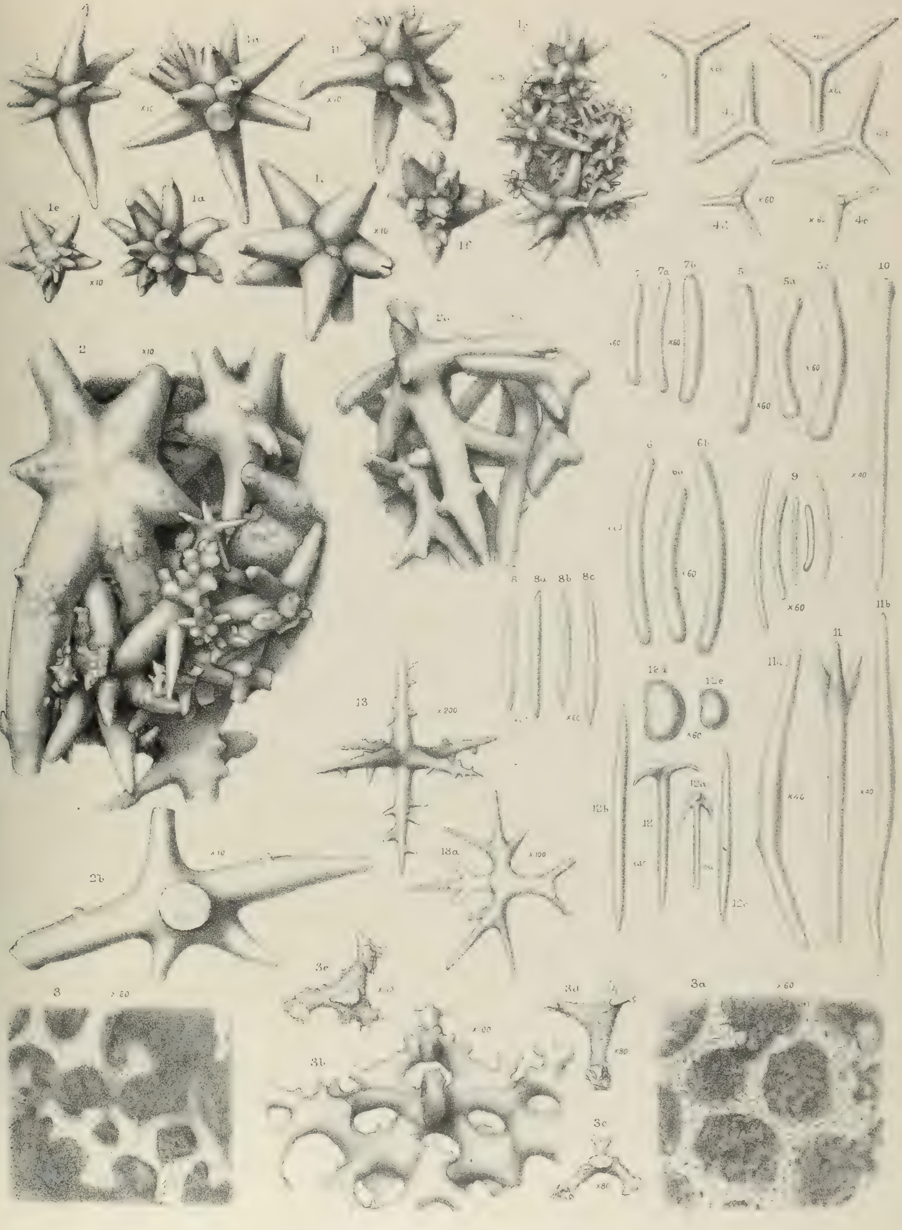
Figs. 12 *d*, 12 *e*.—Two reniform spicules of the dermal layer of the Sponge. Enlarged sixty diameters. From the Chert Sponge-beds of the Yoredale series at Richmond, Yorkshire, and Henblas and Trelogan, Flintshire. My collection.

Figs. 13, 13 *a*.—Flesh Spicules of Hexactinellid Sponges.

Fig. 13.—A detached flesh-spicule with spinous rays. Enlarged two hundred diameters. From the Chert Sponge-beds of the Yoredale series at Richmond, Yorkshire.

Fig. 13 *a*.—An imperfect flesh-spicule. Enlarged one hundred diameters. From a boulder of Carboniferous Chert in the Drift at York. My collection.

PLATE IX.



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PALÆOZOIC SPONGES

THE

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A MONOGRAPH

OF THE

BRITISH PALÆOZOIC PHYLLOPODA

(PHYLLOCARIDA, PACKARD).

BY

PROF. T. RUPERT JONES, F.R.S., F.G.S., &c.,

AND

DR. HENRY WOODWARD, F.R.S., F.G.S., &c.

PART I.

CERATIOCARIDÆ.

PAGES 1—72. PLATES I—XII.

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A MONOGRAPH

ON THE

BRITISH PALÆOZOIC PHYLLOPODA.

(PHYLLOCARIDA, *Packard.*)

INTRODUCTION.

Fossil remains referable only to organisms related to such Phyllopodous animals as *Nebalia*, *Apus*, and *Estheria* have been met with in many of the Geological Formations. Dr. Scouler, in 1835, was the first to treat of one of these fossils, namely, *Argas* (afterwards *Dithyrocaris*), having some alliance to *Apus*. Professor M'Coy, in 1848, and Mr. J. W. Salter, in 1853, described remains of some more or less *Nebalia*-like genera (*Ceratiocaris* and *Hymenocaris*). Subsequently numerous other forms, variously related to the two above-mentioned Crustaceans, have been described and figured by palæontologists at home and abroad. The history of the fossil *Estheriæ* has already been given in a Monograph published by the Palæontographical Society in 1862.

A general view of the generic characters and geological distribution of these fossil *Phyllopoda* is offered in the annexed Table. We may mention that Dr. A. S. Packard, junr., in 1879 and 1883, leaving *Estheria* among the true *Phyllopoda* (*Branchiopoda*), has referred all the other fossil forms in the accompanying list, with which he was acquainted, together with *Nebalia*, to a separate group, the *Phyllocarida* which we now propose to adopt.

TABLE OF THE KNOWN GENERA OF FOSSIL PHYLLOCARIDA.

I.—CARAPACE, UNIVALVE.

I. Flat or slightly convex Shield.

1. Neither sutured nor ridged along the back. Notched in front.

A. *Posterior border entire.*

Middle and Upper Silurian.[1]	1. *Discinocaris,* H. Woodward. 1866.	Round shield; angular notch. (These are possibly the same.)
Triassic.	2. *Aspidocaris,* Reuss. 1867.	
Devonian.	3. ? *Spathiocaris,* Clarke. 1882. Angular notch.	These shields differ in shape. Some of them are probably the *Aptychi* of *Goniatites.*
—	4. ? *Pholadocaris,* H. W. 1882. Sinuous notch.	
—	5. ? *Lisgocaris,* Clarke. 1882. Oblong notch.	
—	6. ? *Ellipsocaris,* H. W. 1882. Rounded notch.	

B. *Posterior border slightly notched.*

—	1. ? *Cardiocaris,* H. W. 1882. Front notch oblong.

C. *Posterior border deeply notched.*

Lower Silurian.[1]	1. ? *Pterocaris,* Barrande. 1882.	Both notches angular.	Test radiately marked.
Lower Silurian and Devonian.	2. *Dipterocaris,* Clarke. 1883.	Both notches angular.	Test ridged along the middle.
Lower Silurian.	3. ? *Crescentilla,* Barrande. 1872.	Both notches angular.	Possibly a sutured form.

2. Ridged along the back. (Like Apus.)

Devonian and Carboniferous.	1. *Dithyrocaris,* Scouler. 1843. Ridged and sometimes prickly. (*Argas,* Scouler. 1835.)	These are possibly the same.
Carboniferous.	2. *Rachura,* Scudder. 1878. (Only telson known.)	

3. Sutured along the back. Notched in front.

Middle and Upper Silurian.	1. *Aptychopsis,* Barrande (and H. W.). 1872. Angular notch.
Lower Silurian.	2. *Peltocaris,* Salter. 1863. Rounded notch.
—	3. *Pinnocaris,* R. E. Jun. 1878. Slight notch. Striæ concentric far back.

II. Folded Shield, bent along the back (like *Nebalia*), so as to form an overarching Carapace, or a pair of attached Valves.

Lingula-flags.	1. *Hymenocaris,* Salter. 1853. Smooth.
Lower Silurian.	2. ? '*Cytheropsis testis,*' Barrande. 1872. Not well known.
Uppermost Devonian or Lowest Carboniferous.	3. *Protocaris,* Baily. 1872. Not well known.

[1] In the old or Murchisonian sense.

II.—CARAPACE, BIVALVE.

I. Pod-like.

Arenig and Lingula-flags.	1. *Caryocaris*, Salter. 1862. Pod-like; elongate, narrow, smooth.
Tremadoc, Silurian, and Devonian (America).	2. *Ceratiocaris*, M'Coy. 1849. Pod-like; subovate, suboblong, &c.; striate.
Upper Silurian.	3. *Physocaris*, Salter. 1860. Round.
Lower Silurian.	4. *Nothozoe*, Barrande. 1872. Oval.
Carboniferous.	5. *Cryptozoe*, Packard. 1886. Suboblong.
Upper Silurian.	6. *Xiphocaris*, T, R. J. and H. W. 1886. (Only telson known.)
Carboniferous.	7. *Colpocaris*, Meek. 1872. Subovate; strongly emarginate at one end (posterior).

II. Pod-like: Oculate.[1]

Upper Silurian.	1. *Emmelezoe*, T. R. J. and H. W. 1886. Subovate.

III. With Swellings (due to internal organs) in the Antero-dorsal Region, one of which, on each Valve, may be ocular.[1]

Devonian.	1. *Echinocaris*, Whitfield. 1880. Leperditioid. Segments spinose.
Upper Silurian.	2. *Aristozoe*, Barrande. 1872. Leperditioid.
—	3. *Orozoe*, Barrande. 1872. Leperditioid.
Devonian.	4. *Elymocaris*, Beecher. 1884. Leperditioid.
—	5. *Tropocaris*, Beecher. 1884. Leperditioid. Wrinkled.
Upper Silurian.	6. *Ptychocaris*, Novák. 1885. Leperditioid. Wrinkled.
—	7. ? *Phasganocaris*, Novák. 1886. (Only telson known.)

IV. With Swellings in the Antero-ventral Region; ocular tubercle not apparent.

Upper Silurian.	1. *Callizoe*, Barrande. 1872. Leperditioid.

V. Conchiferoidal; probably enclosing all the Abdominal Segments.

Tremadoc.	1. *Lingulocaris*, Salter. 1886. Modioloid, and faintly ridged.
Carboniferous.	2. *Solenocaris*, Meek. 1872. Pod-shaped, and concentrically marked.
Silurian.	3. ? *Orthonotella*, Ulrich. 1882. Oblong.
Silurian or Devonian ?	4. *Myocaris*, Salter. 1864. Quadrangular, and ridged obliquely.
Carboniferous.	5. *Leaia*, Jones. 1862. Quadrangular, ridged obliquely, and concentrically marked.
Devonian. Carboniferous. Triassic. Rhætic. Jurassic. Neocomian. Tertiary? Recent.	6. *Estheria*, Rüppel. 1838. (True Phyllopod.) Like a bivalved mollusc, and concentrically marked.

[1] If the "ocular" swellings of the carapace be *eye-spots*, such a character would necessitate the removal of these forms to a separate division. But the nature of these prominences is uncertain.

The Phyllocarida.—We have long held the opinion that the expanded disc-like shields, such as *Peltocaris*, *Discinocaris*, *Aptychopsis*, and some others, were probably related ancestrally to the larval or adult forms of Phyllopods like *Apus*, *Lepidurus*, &c., whilst the relationship between the living *Nebalia* and the numerous genera of Palæozoic Pod-shrimps does not necessarily preclude us from considering these forms as still belonging to the ENTOMOSTRACA, although placed in Packard's order PHYLLOCARIDA.

As to ornamentation, the concentric striæ, marking lines of growth, appear to correspond most closely in character and origin with the similar decoration observable on the valves of *Estheria*, *Limnadia*, &c., so that their absence upon the carapaces of *Apus* and *Nebalia* does not necessarily prove that shields so ornamented cannot be deemed to belong to Crustacea or even to the PHYLLOPODA; whilst many of the carapaces of the fossil genera, *e. g.* *Dithyrocaris*, *Ceratiocaris*, &c., have either concentric or anastomosing striæ covering the entire surface of their carapaces; and these forms are related to *Nebalia*, which has a smooth carapace destitute of ornamentation.

Claus and Gerstaeker are of opinion that *Nebalia* is not a *Phyllopod*. Because *Nebalia* during its embryonal life (whilst still in the egg) passes through the "Nauplius" and "Zoëa stages," which in Decapods occur partly in the free state, it has been regarded by some as a "Phyllopodiform Decapod." The *potentiality* of a form to attain to a higher existence seems to be here mistaken for *actuality*. Since it never attains a higher development, as an adult, than that of a Phyllopod, and has no retrograde metamorphosis, may we not with as equal reason regard *Nebalia* as a highly-organised *Phyllopod*, as to assert that it is a Decapod arrested at the Phyllopod stage?

All who have studied the PHYLLOPODA have been struck by the peculiar points of special interest to be observed in *Nebalia*.[1]

Milne Edwards, in his 'Histoire Naturelle des Crustacés' (1840), places *Nebalia* in the family *Apusidæ* among the Phyllopods; at the same time he remarks, "The *Nebaliæ* are very singular little crustaceans, which, by reason of their stalked eyes[2] and their carapace, approach the PODOPHTHALMIA; they do not, however, possess branchiæ, properly so called, but they respire by the aid of their thoracic feet, which are developed into membranaceous and foliaceous appendages. They resemble in many respects, and establish a passage between *Mysis* and *Apus*."

[1] For a very full account of *Nebalia*, see the 'Twelfth Annual Report of the United States Geological Survey,' Part I, "Geology, Palæontology, and Zoology," 8vo, 1883 (Washington), "A Monograph of the Phyllopod Crustacea of North America, with remarks on the Order *Phyllocarida*," by A. S. Packard, jun., pp. 295—592, and plates i—xxxix. Also the 'American Naturalist' for Oct., Nov., and Dec., 1882, vol. xvi, pp. 785, 861, 945; and G. O. Sars, 'Challenger Reports,' 1885 and 1887.

[2] Pedunculated eyes are also present in *Branchipus* and *Artemia*, so that the stalked eyes of *Nebalia* can scarcely be regarded as an essentially distinctive character.

Baird (1850) founded the family *Nebaliadæ*, and regarded *Nebalia* as a Phyllopod.

Prof. J. D. Dana (1853), in his great work on the Crustacea, retained the family name (*Nebaliadæ*), and he placed the family in the Phyllopoda.

Metschnikoff in 1865 published an abstract of his account of the development of *Nebalia Geoffroyi*, and in 1868 the full essay in the Russian language. Fritz Müller, in his 'Für Darwin,' states that Metschnikoff has observed "that *Nebalia*, during its embryonal life, passes through the 'Nauplius and Zoëa stages,' which in the Decapoda occur partly (in *Penæus*) in the free state." "Therefore," he adds, "I regard *Nebalia* as a Phyllopodiform Decapod."

In 1872 Claus gave an account, with excellent figures, of the external anatomy of *Nebalia Geoffroyi*, and in 1876 he described the internal anatomy.

In 1875 in the account of the Atlantic Crustacea of the "Challenger Expedition," Willemoes-Suhm placed the *Nebaliadæ* among the *Schizopoda*.

In 1879 Dr. A. S. Packard, jun., in the 'American Naturalist,' vol. xiii., p. 128, proposed that *Nebalia* and its fossil allies should be placed in a new order, which he proposed to name the Phyllocarida. Dr. Packard writes:

"The *Nebaliadæ*, represented by the existing genus *Nebalia*, have generally been considered to form a family of Phyllopod Crustacea. Metschnikoff, who studied the embryology of *Nebalia*, considered it to be a 'Phyllopodiform Decapod.' Beside the resemblance to the Decapods, there is also a combination of Copepod and Phyllopod characteristics. The type is an instance of a generalised one, and is of high antiquity, having been ushered in during the earliest Silurian Period, when there were (when we regard the relative size of most Crustacea, and especially of living *Nebaliæ*) gigantic forms. Such was *Dithyrocaris*, which must have been over a foot long, the carapace being seven inches long. The modern *Nebalia* is small, about half an inch in length, with the body compressed, the carapace bivalved as in *Limnadia*, one of the genuine Phyllopods. There is a large rostrum overhanging the head; stalked eyes; and, besides two pairs of antennæ and mouth-parts, eight pairs of leaf-like, short, respiratory feet, which are succeeded by swimming-feet. There is no metamorphosis, development being direct.

"Of the fossil forms, *Hymenocaris* was regarded by Salter as 'the more generalised type.' The genera *Peltocaris* and *Discinocaris* characterise the Lower Silurian Period, *Ceratiocaris* the Upper, *Dictyocaris*[1] the Upper Silurian and the lowest Devonian strata, *Dithyrocaris* and *Argas*[2] the Carboniferous Period. Our existing north-eastern species is *Nebalia bipes* (Fabricius), which occurs from Maine to Greenland.

"The Nebaliads were the forerunners of the Decapoda, and form, we believe, the type of a distinct order of Crustacea, for which the name Phyllocarida is proposed."

[1] Of doubtful alliance. [2] Not separate from *Dithyrocaris*.

The order PHYLLOCARIDA has been thus defined :

PHYLLOCARIDA, Packard (1879). Body long, with five cephalic, eight thoracic, and eight abdominal segments, with a thin or chitinous skin ; generally covered with a bivalved shell having a movable rostrum. Eyes pedunculated and faceted. Upon the under side of the head are two pairs of antennæ, the mandibles, and two pairs of maxillæ furnished with palpi. The body-segments are compressed, they support eight pairs of large Phyllopodiform thoracic feet. The abdomen is composed of eight large segments[1] provided with six pairs of simple swimming-feet fringed with setæ, of which the four anterior pairs are the largest, and the two posterior pairs very small. The abdomen terminates in setaceous filaments, or in a telson divided into three or more parts. (Zittel, 'Handbuch der Palaeontologie,' Munich, 1885.)

In 1880 Professor Claus, 'Lehrbuch der Zoologie,' writes, "This remarkable form (*Nebalia*) was for a long time regarded as a Phyllopod, and in many of its characters it represents a connecting link between the PHYLLOPODA and the MALACOSTRACA. The structure and segmentation of the head and thorax resemble that of the Malacostraca, but the terminal region of the abdomen does not present the special form of a caudal plate or telson. In *Nebalia* we probably have to do with an offshoot of the Phyllopod-like ancestors of the MALACOSTRACA, which has persisted to the present time." He adds, "*Nebalia* is best placed in a special group LEPTOSTRACA, between the ENTOMOSTRACA and MALACOSTRACA. The Palæozoic genera *Hymenocaris*, *Peltocaris*, &c. would have to be placed in such a group."[2]

"It is," writes Professor Claus, "in the highest degree probable that all these [Palæozoic PHYLLOCARIDA] are not true Phyllopods, but have belonged to a type of Crustacea, of which there are no living representatives, but which, taking their origin from forms allied to the lower types of Entomostraca, have prepared the way for the Malacostracan type. Such a connecting link, which has survived to the present day, we evidently find in the genus *Nebalia*."[3]

In his 'Handbuch der Palaeontologie,' Munich, 1885, Professor Dr. K. A. Zittel adopts Packard's order PHYLLOCARIDA, but places it under the MALACOSTRACA, and between the EDRIOPHTHALMIA and the MEROSTOMATA.

In his article on the Palæozoic allies of *Nebalia*, Dr. A. S. Packard, jun., thus sums up the PHYLLOCARIDA : "From our total lack of any knowledge of the nature of the limbs of the fossil PHYLLOCARIDA, we have to be guided solely by analogy, often an

[1] The abdomen is nine-jointed, unless the last somite be considered as the telson (it is post-anal). It is a long and slender segment, and bears two very long narrow setigerous cercopods, closely resembling those of the Copepoda.

[2] Claus, translated by Sedgwick (Cambridge), p. 448 (footnote) ; 8vo, 1884. The *Leptostraca* (Claus) are thus defined : "Crustacea with thin folded carapaces, mostly bivalved, under which all the thoracic rings remain as free segments" (Zittel, 'Handb. Palaeontol.,' 1885, p. 655).

[3] Claus, in 'Siebold und Kolliker's Zeitschrift,' vol. xxii, 1872, p. 329.

uncertain and delusive guide. But in the absence of any evidence to the contrary there is every reason to suppose that the appendages of the head, thorax, and abdomen were on the type of *Nebalia*, since there is such a close correspondence in the form of the carapace, rostrum, and abdomen. But whatever may be the differences between the fossil forms represented by *Ceratiocaris*, &c., they certainly seem to approach *Nebalia* much nearer than any other known type of Crustacea; they do not belong to the DECAPODA; they present a vague and general resemblance to the zoëa or larva of the Decapods, but no zoëa has a telson, though one is developed in a postzoëal stage; they do not belong to any other Malacostracous type, nor do they belong to any existing Entomostracous type, using those terms in the old sense. No naturalist or palæontologist has referred them with certainty to the Decapods or to any other Crustacean type than the Phyllopods. To this type (in the opinion of Metschnikoff and Claus, who have studied them most closely) they certainly do not belong, and thus reasoning by exclusion they either belong to the group of which *Nebalia* is a type or they are members of a lost, extinct group. The natural conclusion, in the light of our present knowledge, is that they are members of the group represented by the existing *Nebalia*." The differential characters separating them from the Decapods or any other Malacostracous type are—

1. The loosely-attached carapace, the two halves connected by an adductor muscle.

2. The movable rostrum, loosely attached to the carapace.

3. The very long and large mandibular palpus, the long slender appendage of the first maxilla, and the very long bi-ramous maxillæ.

4. The absence of any maxillipeds.

5. The eight pairs of pseudo-Phyllopod thoracic feet, not adapted for walking.

[To these we would add—5*a*. The 'telson' long and slender, with two long narrow setigerous cercopods as in the Copepoda.]

6. The animal swimming on its back.

7. No zoëa-formed larva.

The characters which separate it from the Phyllopods are—

1. Carapace not hinged; a rostrum present.

2. Two pairs of well-developed long and large multiarticulate antennæ; the hinder pair, in the male, longer than the first pair.

3. The thorax and its appendages clearly differentiated from the abdomen."[1]

Nebalia has been so long regarded as the surviving representative of those more ancient and gigantic forms of PHYLLOCARIDA, which existed in such numbers in the Cambrian and Silurian Seas, and became nearly extinct towards the close

[1] 'American Naturalist,' 1882, vol. xvi, p. 351; and 'Monograph N.-Amer. Phyllopods,' &c., 1883, pp. 447–8.

of the Carboniferous epoch, that any decision affecting its zoological position cannot be a matter of indifference to the palæontologist.

But after studying its larval development and adult structural modifications, we arrive at the fact that *Nebalia* is a more generalised type than is ordinarily to be found at the present day, "combining Copepod, Phyllopod, and Decapod-like features, with other more fundamental characters of its own" (Packard), which preclude us from regarding it as a true Malacostracan, and, although ancestrally related to that order, it nevertheless does not attain, in our opinion, to the Malacostracan grade of development.[1] The group should therefore be arranged in a distinct order (the PHYLLOCARIDA) between the ENTOMOSTRACA and the MALACOSTRACA, as suggested by Claus. But if it is undesirable to have such an outstanding group, then we contend that the balance turns in favour of retaining it in the former division, if not in the order PHYLLOPODA as heretofore.

Thus we conclude—

1. Some of the supposed "Phyllopod shields" from the Eifel and elsewhere are probably *Aptychi* of *Goniatites*.

2. That for others of the Palæozoic Phyllopods, described in our Reports of 1883-84 (British Association), this explanation is inadmissible.

3. That those which cannot be referred to *Aptychi* are still, in all probability, Phyllopods (Phyllocarids).

4. That the *Nebalia*-like forms, now placed in the order PHYLLOCARIDA, are *certainly not Decapods*. And even if they may not with propriety be retained any longer in the old order PHYLLOPODA (of which we are by no means sure), yet they may more correctly be placed beside them in the ENTOMOSTRACA than in the MALACOSTRACA, seeing they have not actually attained to the grade of the latter, but only approached to its larval development; whilst with the former the adult *Nebalia* has many very strong points of affinity.

CERATIOCARIDÆ.—Dr. Packard's observations on the structure of the Phyllopods, and his studies of the comparative anatomy of living and fossil forms, supply the palæontologist with sound reasoning in referring the *Phyllocarida* to the Nebaliad type as a centre for a great group of obscure fossil forms, and as a starting-point for the Decapoda. We have referred to his views in some detail in the foregoing pages, and it is our present intention to treat of the group typified by CERATIOCARIS, which has more than others a strict alliance to the recent *Nebalia*.

[1] Dr. Packard writes "There is little to indicate that the Schizopods (*Mysis*, &c.) have descended from a *Nebalia*-like form, but rather from some accelerated zoëa form; while the Phyllocarida *have had no Decapod blood in them*, so to say, but have descended by a separate line from Copepod-like ancestors, and culminated, and even began to disappear, before any Malacostraca, at least in any numbers, appeared" ('American Naturalist,' 1882, vol. xvi, p. 873). In his "Report on the Schizopoda collected by the Challenger," 1885, and "On the Phyllocarida," 1887, Prof. G. O. Sars treats of *Nebalia* as being not a true Phyllopod, but a "*Copepodiform Branchiopod*;" p. 5.

In describing the parts in the fossil forms, we have to deal with—

1. The two *valves* of the *carapace*, and the *rostrum* in front between them (rarely present). Their *ventral rim*, *raised*, and occasionally *pitted* with the bases of lost *setæ* or *prickles*. Their superficial *ornament*. In some allied forms *tubercles* or *nodes* are present, one of which may be distinguished as an *optic tubercle* or *eye-spot;* while others are due to the *maxillæ* (*teeth*), or other mouth-organs, or to places of attachment for the *buccal muscles* of the masticatory apparatus. The *cephalic region* of the valve is sometimes marked off from the *thoracic* by a slight *sulcus* (the *nuchal furrow ?*).

2. The *somites* or *abdominal segments* vary in number; some are covered by the carapace, others exposed. Their *articulation ; superficial ornament ;* occasional *prickles ;* their appendages (*uropods*) rare; and *terminal spines*. The *ultimate segment* has its own special characteristics.

3. The *caudal appendages* or *spines*, consisting of a median *telson*[1] (*urosome*) or *style*, and two smaller lateral *stylets* or *cercopods*. Their *ridges* and *furrows*, and *pits*, indicating bases of little spines or spinules, former *setæ*, *fringes*, or *fimbriæ*. The *proximal end of the telson* has often its special ornamentation.

Genus Ceratiocaris, *M'Coy*, 1849.

1839. *Onchus*, Agassiz (in part). In Murchison's 'Silurian System,' p. 607.
1848. — Phillips (in part). 'Mem. Geol. Surv.,' vol. ii, Part 1, p. 226.
1849. *Pterygotus*, M'Coy. 'Ann. Mag. Nat. Hist.,' ser. 2, vol. iv, p. 394.
1849. *Ceratiocaris*, M'Coy. 'Ann. Mag. Nat. Hist.,' ser. 2, vol. iv, p, 412.
1851. *Ceratiocaris*, M'Coy. 'Brit. Palæoz. Fossils,' Fasc. 1, p. 136.
1851. *Pterygotus*, M'Coy. 'Brit. Palæoz. Fossils,' Fasc. 1, p. 175.
1851. *Leptocheles*, M'Coy. 'Brit. Palæoz. Fossils,' Fasc. 1, p. 176.
1851. *Pterygotus* (*Leptocheles*), Bronn. 'Lethæa Geognost.,' vol. i, Part 1, p. 40.
1852. *Onchus*, James Hall. 'Geol. Surv. New York, Palæontology,' vol. ii, p. 320.
1852. *Ceratiocaris*, Bronn. 'Lethæa Geogn.,' vol. i, Part 2, p. 539.
1853. *Dithyrocaris*, Geinitz. 'Verst. Grauwack. Sachsen,' Heft ii, p. 23.
1853. *Leptocheles*, M'Coy. 'Quart. Journ. Geol. Soc.,' vol. ix, p. 13.
1853. *Ceratiocaris* (*Leptocheles*), Barrande. 'Neues Jahrb. für Min.,' &c., 1853, Heft iii, p. 342.
1853. *Dithyrocaris ?*, D. Sharpe. 'Quart. Journ. Geol. Soc.,' vol. ix, p. 158.
1854. *Ceratiocaris et Leptocheles*, Murchison. 'Siluria,' 1st. edit., p. 236.
1854. *Ceratiocaris*, Morris. 'Catal. Brit. Foss.,' 2nd edit., p. 102.
1856. — Salter. 'Quart. Journ. Geol. Soc.,' vol xii, p. 33.

[1] This is really the last joint (somite) of the abdomen.

1859.	*Ceratiocaris,*	James Hall. 'Geol. Surv. New York, Palæntology,' vol. iii, p. 240.
1859.	—	Salter. In Murchison's 'Siluria,' 2nd edit. (3rd, including 'Sil. Syst.'), pp. 262, 538.
1860.	—	Salter. 'Ann. Mag. Nat. Hist.,' ser. 3, vol. v, p. 158.
1863.	—	James Hall. 'Sixteenth Ann. Rep. of the Regents, State Cabinet, New York,' p. 72, pl. 1.
1865.	—	J. W. Salter and H. Woodward. 'Catal. and Chart of Foss. Crustacea,' p. 17.
1865.	—	H. Woodward. 'Geol. Mag.,' vol. ii, p. 401.
1865.	—	Huxley and Etheridge. 'Catal. Foss. Mus. Pract. Geol.,' p. 79.
1866.	—	H. Woodward. 'Geol. Mag.,' vol. iii, p. 203.
1866.	—	Salter. 'Mem. Geol. Surv.,' vol. iii, p. 294.
1867.	—	Salter. In Murchison's 'Siluria,' 3rd. edit. (4th, including 'Sil. Syst.'), pp. 236 and 516.
1868.	—	Bigsby. 'Thesaurus Siluricus,' p. 73.
1871.	—	H. Woodward. 'Geol. Mag.,' vol. viii, p. 104.
1872.	—	H. Woodward. 'Geol. Mag.,' vol. ix, p. 564; and 'Report Brit. Assoc.' for 1872, p. 323.
1872.	—	Barrande. 'Syst. Sil. Bohême,' vol. i, Suppl., p. 437.
1873.	—	Salter. 'Cat. Cambr. and Sil. Foss. Woodw. Mus.,' p. 177.
1873.	—	R. Etheridge, junr. 'Mem. Geol. Surv. Scotl., Expl. Map 23,' p. 93.
1873.	—	Marschall. 'Nomenclator Zoologicus,' p. 404.
1874.	—	R. Etheridge, Junr. 'Ann. Mag. Nat. Hist.,' ser. 4, vol. xiv, p. 9.
1876.	—	Ferd. Roemer. 'Lethæa geognost,' Theil i; 'Leth. palæozoica,' Explanation of pl. 19.
1877.	—	H. Woodward. 'Catal. Brit. Foss. Crust.,' p. 70.
1877.	—	Miller. 'Catal. Palæoz. Foss. America,' p. 213.
1878.	—	Huxley, Newton, and Etheridge. 'Catal. Foss. Mus. Pract. Geol.,' p. 84.
1878.	—	Bigsby. 'Thes. Devonico-Carbonif.,' pp. 26, 246 and 247.
1878.	—	Young. 'Proceed. Roy. Phys. Soc. Edin.,' vol. iv, p. 168.
1880.	—	Whitfield. 'Amer. Journ. Sci.,' ser. 3, vol. xix, p. 35.
1882.	—	B. N. Peach. 'Trans. Roy. Soc. Edin.,' vol. xxx, part 1, p. 73.
1883.	—	A. S. Packard, junr. 'Monogr. North-Amer. Phyllop. Crust.; Twelfth Ann. Rep. U.S. Geol. and Geograph. Survey,' p. 450.

1883. *Ceratiocaris*, Fr. Schmidt. 'Mém. Imp. Acad. Sci. St.-Pétersb.,' ser. 7, vol. xxxi, p. 84.
1883. — T. R. J. and H. W. 'Report Brit. Assoc. for 1883,' p. 217.
1884. — C. E. Beecher. "Ceratiocaridæ Upper-Devonian Measures," 'Second Geol. Surv. Pennsylvania, P.P.P.,' p. 2.
1884. — T. R. J. and H. W. "Second Report on Palæoz. Phyllop.," 'Report Brit. Assoc. for 1884,' p. 95.
1884. — T. R. J. and H. W. 'Geol. Mag.,' dec. 3, vol. i, pp. 356, 396.
1885. — O. Novák. 'Sitzungsb. k. böhm. Gesellsch. Wissensch.,' Jahrg. 1885, p. 239.
1885. — T. R. J. and H. W. 'Third Report Pal. Phyll., Brit. Assoc. for 1885,' p. 334.
1885. — H. Woodward. 'Geol. Mag.,' dec. 3, vol. ii, p. 349.
1885. — T. R. J. and H. W. Ibid., pp. 385 and 460.
1885. — J. M. Clarke. 'Geolog. Succession in Ontario Co., New York,' pp. 18 and 20.
1886. — T. R. J. and H. W. 'Fourth Report Pal. Phyll., Brit. Assoc. for 1886,' p. 229.
1886. — T. R. Jones. 'Geol. Mag.,' dec. 3, vol. iii, p. 456.

The generic characters of *Ceratiocaris* have been described by M'Coy, Salter, H. Woodward, and Barrande in their several works and memoirs referred to above and in the sequel. James Hall, R. P. Whitfield, A. S. Packard, J. M. Clarke, Fr. Schmidt, C. E. Beecher, O. Novák, and others have added much information, general and special, on this and allied genera. The foregoing synonymy of the genus supplies references to published observations on *Ceratiocaris* and some of its allies.

We offer the following diagnosis of *Ceratiocaris*. Carapace bivalved, probably with membranous attachment, no distinct hinge-joints being observable; valves subovate, semiovate, subquadrate, or trapezoidal; contracted in front, with the end sharp or rounded above the median line of the valve; more or less truncate behind. Rostrum elliptical in shape, of a single lanceolate piece, chevron-marked. Antennæ (?) obscure. Maxillæ often apparent. Body many-jointed, with fourteen or more segments, of which 4—7 extend beyond the carapace, ornamented with delicate raised lines. Some or all of these segments bore small lamelliform branchial appendages.[1] Last segment the longest, supporting three caudal spines, namely: (1) a strong tapering telson (style), thick at the top or proximal end, usually with a trilobed articulating surface (resembling that in the telson of *Limulus*), pointed at the other, and more or less spinose, as shown by the bases of little prickles; and (2) two shorter, simpler, lateral appendages (stylets). The surface

[1] See the "Sixth Report on Fossil Crustacea," 'Brit. Assoc. Rep. for 1872,' p. 323.

of the valves has a linear ornament, and the ventral margin has a thin raised rim, furnished, in some instances, with small tubercles or a fine spinose fringe.

Respecting the abdominal appendages which Mr. R. Etheridge, jun., described in Appendix III of the 'Memoirs Geol. Survey Scotland, Explanation of Sheet 23,' 1873, p. 93, he there remarks:

"A further advance in the structure of this genus of Crustacea has been satisfactorily established from specimens obtained at Lesmahagow by the Collector of the Geological Survey, viz. the presence of respiratory locomotive appendages. On a slab of thin-bedded shale are exposed the abdominal segments, telson, and caudal appendages of a *Ceratiocaris*. From the ventral margin of the terminal segment, to which are attached the telson-spines (*Leptocheles*, M'Coy), proceeds a broad, paddle-shaped, membranous (?) expansion, presenting a strong marginal outline, with a transversely striated surface. This is followed by another similar appendage, proceeding in the same manner from the penultimate segment (somite). Along the dorsal margin there is seen what appears to be the remains of one of the corresponding 'foot-gills,' on the other side, bent back upon itself, and thus thrust out of place. The free ends of these foot-gills are attenuated to more or less rounded points. They do not show any evidence of having possessed a marginal fringe. The discovery of these branchial locomotive appendages tends to ally *Ceratiocaris* still further with the genus *Nebalia*. See 'Geol. Mag.,' vol. ix, p. 564. *Loc.:* No. 292 (Linburn or Linn Burn, about two miles north of Muirkirk, Lanarkshire). In thin-bedded shale (Upper Ludlow). Collected by A. Macconochie."

Fig. 1.

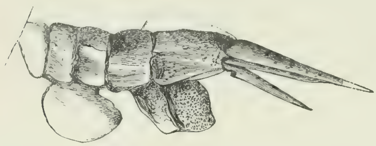


Fig. 2.

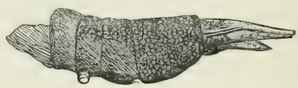


Fig. 1.—Abdominal segments and caudal spines of *Ceratiocaris stygia*, with indications of branchial lamellæ or uropods, Geol. Surv. Mus. Edin., M. 101, Linburn.

Fig. 2.—Abdominal segments and caudal spines of *Ceratiocaris papilio*, with indications of uropod, Geol. Surv. Mus. Edinb., M. 94, Linburn

Mr. R. Etheridge, jun., again alludes to this interesting subject in the 'Annals and Mag. Nat. Hist.' ser. 4, vol. xiv, 1874, p. 9.

Some of the abdominal segments seem to exhibit joint-marks or surfaces of articulation adapted for appendages rather than for union with the next somite. Compare Pl. III, fig. 3.

Ceratiocaris leptodactylus (M'Coy) and *C. Murchisoni* (Agassiz), having been the first recorded species, will be here described first.

The following is a list of the British Palæozoic Ceratiocaridæ and allies, as at present known, and treated of in this portion of the Monograph.

		Plates
1.	*Ceratiocaris leptodactylus*, M'Coy.	VI, X
2.	— *Murchisoni*, (Agass.),	III, IV, V, VI
3.	— *valida*, T. R. J. & H. W.	VI
4.	— *tyrannus*, Salter.	III, IV, V, IX
5.	— *gigas*, Salter.	III, IV, V
6.	— *Halliana*, T. R. J. & H.W.	II, IV, V
7.	— *Pardoëana*, La Touche.	V
8.	— *canaliculata*, T. R. J. & H. W.	IX
9.	— *Ludensis*, H. W.	I, IX
10.	— *papilio*, Salter.	XI, XII
11.	— *stygia*, Salter.	X, XI, XII
12.	— *longa*, sp. nov.	VI, XI
13.	— *robusta*, Salter.	X, XI
14.	— *patula*, sp. nov.	XI
15.	— *angusta*, T. R. J. & H. W.	X
16.	— *minuta*, T. R. J. & H. W.	X, XI
17.	— *inornata*, M'Coy.	X
18.	— *Ruthveniana*, T. R. J. & H. W.	X
19.	*Ceratiocaris Oretonensis*, H. W.	X
20.	— *truncata*, H. W.	X
21.	— *solenoides*, M'Coy.	VIII
22.	— *gobiiformis*, T. R. J. & H. W.	VIII
23.	— *Salteriana*, T. R. J. & H. W.	VII
24.	— *laxa*, T. R. J. & H. W.	VIII, X
25.	— *compta*, T. R. J. & H. W.	VII
26.	— *cassia*, Salter.	VII
27.	— *cassioides*, T. R. J. & H. W.	III, IV, VII
[28.	*C.? longicauda* (Sharpe), Portuguese].	XI
29.	*C. decora*, Phillips.	
30.	*C.? lata*, Salter.	
31.	*C.? insperata*, Salter.	
32.	*C.?* sp.?	
33.	*C.? perornata*, Salter.	
1.	*Xiphocaris ensis* (Salter).	V
1.	*Physocaris vesica*, Salter.	VII

Oculate Forms.

1.	*Emmelezoe elliptica* (M'Coy).	VIII
2.	— *crassistriata*, T. R. J. & H. W.	VIII
3.	— *tenuistriata*, T. R. J. & H. W.	VII
4.	— *Maccoyiana*, T. R. J. & H.W.	VIII

In acknowledging the obligations we owe to numerous friends who have aided us in becoming acquainted with all the specimens illustrative of the above-mentioned species, we must refer to the names associated with them in our descriptions; also to the Officers of the several Museums from which we have been granted the loan of specimens to draw and describe. We cordially thank the Artists for the care shown in so admirably illustrating this Monograph.

Note.—The specimens indicated in this Monograph as Oxford Museum A—U, and those indicated as Ludlow Museum A—U, were examined and so marked by us in those Museums. Those in the Cambridge Museum, the British Museum, and the Museum of Practical Geology are indicated in this Monograph by the labels attached to them in those collections.

1. Ceratiocaris leptodactylus (*M'Coy*), 1849. Plate VI, figs. 4 *a*, 4 *b*, 4 *c*, 5, 6 (?), 7, 8, 9, and Pl. X, fig. 8 (?).

1849. Pterygotus leptodactylus, *M'Coy*. Ann. Mag. and Nat. Hist., ser. 2, vol. iv, p. 394.
1851. — — — Synops. Brit. Palæoz. Foss., Fasc. i, p. 176, pl. 1 E, figs. 7, *7a*, *7b* (not figs. *7c*, *7d*).
1853. Leptocheles — — Quart. Journ. Geol. Soc., vol. ix, p. 13.
1859. — — *Murchison*. Siluria, 2nd (3rd) ed., p. 263, 538.
1860. Ceratiocaris — *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 157.
1867. Leptocheles (Ceratiocaris) leptodactylus, *Salter*. In Siluria, 3rd (4th) ed., p. 237.
1867. Ceratiocaris leptodactylus, *Salter*. Ibid., p. 516.
1873. — — — Catal. Camb. Sil. Foss., p. 164.
1877. — — *H. Woodward*. Catal. Brit. Foss. Crust., p. 71.
1878. — Murchisoni (part), *Huxley, Newton & Etheridge*. Catal. Foss., M. P. G., p. 84.
1885. — leptodactylus, *T. R. Jones & H. Woodward*. Third Report on Palæoz. Phyllop., Brit. Assoc. Rep., p. 339; Geol. Mag., dec. 3, vol. ii, p. 388.
1886. — — — Fourth Rep., Brit. Assoc. Rep., p. 229; Geol. Mag., dec. 3, vol. iii, p. 456.

Some imperfect specimens (Cambridge Museum, *a*/923 and *a*/924) of the delicate caudal appendages of a *Ceratiocaris* (Pl. VI, figs. 4, 5) from Leintwardine, in Shropshire,[1] were referred by Prof. M'Coy at first to a chelate limb of *Pterygotus*, and then to that of a different but allied genus (*Leptocheles*). Ultimately Mr. Salter gave them their true place in *Ceratiocaris*. In 1877 this species was grouped with *C. Murchisoni* in the 'Catalogue of British Fossil Crustacea,' p. 71; and it was regarded as a variety of that species, also, in our 'Third Report on Palæozoic Phyllopoda,' 1885, pp. 336—339. We now find, however, that it is different both as to size and proportion; and we have detected two rows of little

[1] The very rich localities for Silurian Phyllopods in the neighbourhood of Ludlow are enumerated and described in the Rev. J. D. La Touche's 'Manual of the Geology of Shropshire,' 1884, pp. 26, 27, especially Ludford Lane, Bow Bridge, Leintwardine, Church Hill, and Trippleton Farm. In his 'Record of the Rocks,' 1872, p. 124, &c., the Rev. W. S. Symonds notices Ludlow and its environs from a geologist's point of view. See also 'Siluria,' 1867, chap. vii, pp. 123, *et seq.*

pits, which were the bases of setæ, on the exposed surface of one of the specimens in the University Museum at Cambridge (Pl. VI, fig. 4 *b*).

In each case we have only caudal spines to deal with; but M'Coy's specimens ('Brit. Pal. Foss.,' pl. 1 E, figs. 7, 7 *a*, 7 *b*) are much more slender than Murchison's ('Sil. Syst.,' pl. 4, figs. 10 and 64, and 'Siluria,' last edit., pl. 19, figs. 1, 2), and less strongly ribbed; and therein they have specific differences.

Some similar caudal appendages (Mus. Pract. Geol. $\frac{17}{14}$) occur in the Lower-Wenlock Rock of Helm Knot, Dent, Yorkshire. Some doubtful fragments of ultimate segments of the abdomen are shown in Pl. VI, fig. 6, and Pl. X, fig. 8.

In 1860 Mr. Salter apportioned to this species a certain kind of carapace which we think belongs to a new species (*C. Halliana*, which see further on).

Pl. VI, figs. 4 *a*, 4 *b*, 4 *c*. Cambridge Museum *a*/924. Described and figured by M'Coy, 'Brit. Pal. Foss.,' 1851, pl. 1 E, figs. 7 and 7 *b*, as *Pterygotus leptodactylus*, from Leintwardine. This specimen is in faintly greenish-grey mudstone, slightly calcareous along thin seams at the edge. It consists of a small fragment (smaller than when figured by M'Coy) of the distal (lower) end of an ultimate segment, longitudinally striate, and a ridged telson. The latter, not fully exposed at the end, retains portions of its test; some of these pieces, low down, are small, but the proximal portion or head of this telson is well characterised by its leaf-marked or latticed test (4 *a*, 4 *c*). The junction of segment and telson have been disturbed by pressure.

The outer ridge of the telson and the third ridge inwards bear numerous marks of the bases of small prickles (figs. 4 *a*, 4 *b*, 4 *c*). Whether the outer edge represents the back or the side of the dorsal ridge (that is, if it bore more than the one visible row of marks) is doubtful; the telson may have had a double row of prickles along its back, one on each side of the ridge. The inner row on the third ridge is an interesting and special feature.

Figure 5 (Cambridge Museum *a*/923). Described and figured by M'Coy ('Brit. Pal. Foss.,' pl. 1 E, fig. 7 *a*). In olive-grey sandstone, not calcareous. From Leintwardine. A longitudinally ridged telson, badly preserved, but retaining a striated fragment of ferruginous crust.

Pl. VI, figs. 6, 7, 8, 9. Museum Practical Geology $\frac{17}{14}$, $_{1,2,3,4}$. Labelled "C. Murchisoni, M'Coy, Coniston Grit.,[1] Helm Knot, Dent, Yorkshire. Collected by Prof. M'K. Hughes." See also 'Catal. Cambr. Silur. Fossils,' 1878, p. 84, and 'Geol. Mag.' vol. iii, p. 205. Hard, olive-green, and brownish mudstone, not calcareous, with poorly-preserved ferruginous impressions.

Fig. 6. Probably part of an ultimate segment, longitudinally striated. The obscure, irregular, deeper, and continuous hollow may possibly have reference to a telson.

Fig. 7. A style (broken) and two stylets. All ridged throughout; the first

[1] Equivalent to the "Wenlock Shale" (Lower Wenlock).

bearing indications of two rows of the bases of prickles on its upper portion, and thus corresponding with fig. 4; it is imperfect at the end. The others are probably perfect in length.

Fig. 8. A similar, but smaller, set of caudal appendages; all ridged; only the style retaining its full length.

Fig. 9. Style and stylets pressed together. The end of the former is still in the matrix. Some indistinct traces of spine-bases are seen on its lower portion, but not represented in the drawing.

Pl. X, fig. 8 (British Museum 44342). Benson Knot,[1] Kendal. Dark grey sandstone, somewhat micaceous, and slightly calcareous.

C. LEPTODACTYLUS.—*Carapace.*—Not known.

Ultimate Segment.—With longitudinal anastomosing wrinklets.

Caudal Appendages.—Slender, ridged and fluted.

Head of Telson.—With lattice ornament and anastomosing longitudinal wrinklets.

Style (*telson*).—Fluted, and pitted in two rows on the side (as exposed).

Stylets.—Delicately fluted.

Length of	Fig. 4.	Fig. 5.	Fig. 7.	Fig. 8.	Fig. 9.
Style.........	65 mm. (imperfect).	65 mm.	50 mm. (broken).	40 mm.	50 mm. (imperfect).
Stylet.........	—	—	55 mm.	—	28 mm.

A specimen in the Museum of Practical Geology, marked D $\frac{22}{13}$ ('Catal. Cambr. and Sil. Fos., M. P. G.,' 1878, p. 118), from Dudley, a thin curved telson (?), delicately striate, is probably *C. leptodactylus.*

In Barrande's 'Syst. Sil. Bohème,' vol. i, Supp., pl. 19, figs. 14—16 of *C. inæqualis* are comparable with *C. leptodactylus.*

2. CERATIOCARIS MURCHISONI (*Agassiz*), 1839. Pl. III, figs. 4 *a*, 4 *b*, 7; Pl. IV, figs. 1 and 3; Pl. V, fig. 3; Pl. VI, figs. 1 and 2.

1839. ONCHUS MURCHISONI, *Agassiz.* In Silur. Syst., p. 607, pl. 4, fig. 10 (not figs. 9 and 11); and *Onchus,* fig. 63 ?, and Ichthyodorulite, fig. 64.

1851. LEPTOCHELES (MURCHISONI), *M'Coy.* Synops. Brit. Pal. Foss., Fasc. 1, p. 176.

1853. — MURCHISONI, — Quart. Journ. Geol. Soc., vol. ix, p. 13 (omitting allusion to figs. 9 and 11, Sil. Syst.).

1853. DITHYROCARIS — *Geinitz.* Verstein. Grauwackenformation in Sachsen, Heft ii, p. 24, pl. 19, fig. 13.

[1] "The micaceous flags of Benson Knot belong to what are locally called 'Kirkby-Moor Flags'—*i. e.* Upper Ludlow."—Prof. T. M'K. Hughes, 'Geol. Mag.,' vol. iii, p. 208.

1854.	Leptocheles Murchisoni, *Murchison.*	Siluria, 1st ed., p. 236, pl. 19, figs. 1, 2.
1859.	— — —	Siluria, 2nd ed. (3rd, including Sil. Syst.), pp. 263, 538, pl. 19, figs. 1, 2.
1860.	Ceratiocaris — *Salter.*	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 157.
1866.	— — *Jones.*	Ibid., ser. 3, vol. xviii, p. 40.
1866.	— — *H. Woodward.*	Geol. Mag., vol. ii, p. 205, pl. 10, figs. 8, 9.
1867.	Leptocheles — *Salter.*	In Siluria, 3rd. ed. (4th ed., including Sil. Syst.), p. 134, pl. 19, figs. 1, 2.
1867.	— (Ceratiocaris) Murchisoni, *Salter.*	Ibid., p. 237, pl. 19, figs. 1, 2.
1867.	Ceratiocaris Murchisoni, *Salter.*	Ibid., p. 516, pl. 19, figs. 1, 2.
1877.	— — (part), *H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1878.	— — — *H. N. & E.*	Catal. C. S. Foss., M. P. G., pp. 84, 168.
1878.	— tyrannus — —	Ibid., p. 118.
1885.	— Murchisoni (part), *T. R. J. & H. W.*	Third Rep. Pal. Phyllop., Brit. Assoc., p. 339; Geol. Mag., Sept., 1885, p. 387.
1886.	— — *T. R. J. & H. W.*	Fourth Rep., Brit. Assoc., p. 229; Geol. Mag., Oct., 1886, p. 456.

Some imperfect caudal appendages or spines (telson or style, and lateral spines or stylets) from the Uppermost Ludlow strata, near Ludlow, were figured in Murchison's 'Silurian System,' in 1839, as fish-defences. These were recognised by Prof. F. M'Coy in 1853 as being very similar to some analogous fossils, referred by him at first (in 1849) to a slender-clawed kind of *Pterygotus* from the Lower Ludlow, at Leintwardine, near Ludlow, but which he afterwards separated from that genus as *Leptocheles leptodactylus.* M'Coy suggested that Murchison's fossil should be known as *L. Murchisoni.*

Prof. M'Coy's observations are as follows:—". . . . . . As before mentioned, figs. 9, 10, and 11 ['Sil. Syst.,' pl. 4; omit figs. 9 and 11], representing the so-called *Onchus Murchisoni*, Ag., are almost identical in form, size, sculpturing, and all other characters (as far as they are represented in these drawings), with the distinctly didactyle pincers which I have figured ('Brit. Pal. Foss.,' pl. E, fig. 7) from Leintwardine, under the name *Lept. leptodactylus.* . . . . If this approximation prove correct, the fossil should in future be called *Leptocheles Murchisoni* (Ag. sp.)." 'Quart. Journ. Geol. Soc.,' vol. ix, 1853, p. 13.

C. Murchisoni, founded on the specimens figured in 'Sil. Syst.' and 'Siluria,' but now unfortunately mislaid, is represented by several analogous fossils, such as Oxford Museum B and C; Ludlow Museum C; M. P. G. $\frac{23}{33}$ and $\frac{23}{36,1}$. We find only one row of pits on the styles, as exposed. We have been unable to determine its carapace. The carapaces assigned by Salter to *C. leptodactylus* and *C. Murchisoni* are not accepted by us. We formerly thought that they belonged to one species, but now regard them as distinct.

Several good examples of more or less perfect sets of three caudal spines, corresponding in size, strength, curvature, and ribbing with Murchison's fossils, have been met with. Some of these show evidence of lines of prickles (by the presence of little pits, representing their bases), and on close examination the engravings in the 'Sil. Syst.' and 'Siluria' (the specimens have been mislaid) show some slight indications of this spinose ornament.

We have not found a carapace directly associated with any tail-spines of either the *Murchisoni* or the *leptodactylus* type. With regard to both however, the late Mr. J. W. Salter satisfied himself that he knew their special carapaces, for he described them at p. 157 of the 'Ann. Mag. Nat. Hist.' for March, 1860, where also he refers both species to the *Ceratiocaris* of M'Coy. Judging from his Latin diagnoses, he allocates to the former "a cephalothorax (carapace) two inches long, oblong, convex, ornamented with interrupted, nearly straight, wide-apart lines. The caudal appendages long, sub-cylindrical; the central spine (telson) strong, bulbous at its base, and with a strong dorsal rib; the side spines long. All ribbed. The whole animal medium-sized. Specimens possessed by the geologists at Ludlow and by the Museum of Practical Geology." The carapace described here does not agree with any that we can associate with the caudal spines intended.

Pl. III, fig. 4 *a*. Four body-segments with outside test, and impressed caudal spines. Ornamentation consisting of longitudinal, abrupt, delicate wrinklets; and on the head of the crushed telson strong leaf-like anastomosing lines. Fig. 4 *b*. A segment, magnified, showing the ornament.

Mus. Pract. Geol.; one of those marked "$\frac{23}{33}$. *C. tyrannus*, Salter." 'Catal.,' 1878, p. 118. Leintwardine. In brownish-grey mudstone.

Pl. III, fig. 7. Two stylets, irregularly rugose (probably decomposed). Mus. Pract. Geol. "$\frac{23}{33}$. Wyatt-Edgell Collection, 1878. Lower Ludlow; Leintwardine. *Ceratiocaris Murchisoni*, M'Coy." See 'Catal.,' p. 118. In darkish olive-grey micaceous mudstone.

Pl. IV, fig. 1. Head of telson leaf-marked, crushed; top of stylet with rounded head, in place: the rugosities on the stylets are probably due to decomposition. There are some regular pittings on the style (=4 inches=105 mm.), which is ridged, as also are the stylets. Oxford Museum B. In brownish-grey mudstone; Lower Ludlow. Marked "*Murchisoni.*"

Pl. IV, fig. 3. A set of caudal appendages, imperfect at the ends. One semicircular acetabulum on the telson head for articulation with the angle of the ultimate segment, and the other (below) for a stylet (broken across its neck), are well shown. Pitting present on the style; none on stylets. Style and stylets ridged and fluted. Oxford Museum C. Lower Ludlow. Olive-grey sandstone.

Pl. V, fig. 3. A style (telson) and a stylet, both having longitudinal smooth ridges, partly preserved. The telson seems at first sight to show five ridges, but there are really two main lateral ridges, one delicately keeled for part of its length, and the other (nearer the dorsum) is deeply fluted, and in the furrow is a series of small sub-oval pits, each with a central nipple, the bases of former prickles. In greenish-grey mudstone, not quite uniform in texture, and mottled with brownish patches; calcareous in parts. Ludlow Museum C. Lower Ludlow. Church Hill, Leintwardine. Collected by Mr. H. Pardoe. This specimen C (fig. 3) was cemented to B (Pl. V., fig. 1), and labelled "*Ceratiocaris Pardoensis*," in the Ludlow Museum, but they do not correspond, being exposed with different aspects, and not agreeing in size and proportions.

Plate VI, figs. 1 and 2. Copied from 'Siluria,' 3rd edition (published as the 4th, including the 'Silurian System'), 1867, pl. 19, figs. 1 and 2, which had been transferred as lithographs from the engravings in the 'Silurian System,' 1839, pl. 4, figs. 10 and 64, to 'Siluria,' 1st edition (published as the 2nd), 1854, pl. 34, fig. 1, and pl. 35, fig. 13.

Fig. 1. 'Siluria,' 1854, *Leptocheles*, pl. 19, fig. 1; 1867, pl. 19, fig. 1. 'Silurian System,' 1839, *Onchus*, pl. 4, fig. 10, said to be from the Uppermost Ludlow Beds ("the Downton series") at the Tin Mill, Ludlow. Fragments of a style (telson) and two stylets, all ridged and furrowed. The broken piece lying obliquely at the top is evidently a part of the style, and not of a stylet, as its end lies upon the former. Some small spots at the lower end of the style possibly indicate the bases of prickles.

Fig. 2. 'Sil. Syst.,' 1839, Ichthyodorulite, pl. 4, fig. 64; 'Siluria,' 1854, *Leptocheles*, pl. 19, fig. 2; 'Siluria,' 1867, pl. 19, fig. 2. Fragment (proximal end) probably of a ridged style, its shape modified by embedment. A line of dots seems to be referable to the bases of prickles.

C. Murchisoni.—*Carapace.*—Not known.

Segments.—Straight wrinkles passing backwards into lattice-pattern at the edge.

Appendages.—Long and strong, slightly curved, convexity dorsal.

Telson.—Ridged and fluted, pitted along two rows (one on each side); slightly curved downwards.

Telson-head.—Irregular wavy striæ with partial lattice-work ornamentation.

Stylets.—Ridged and fluted.

Length of	Pl. III, fig. 4.	Pl. III, fig. 7.	Pl. IV, fig. 1.	Pl. V, fig. 3.	Pl. VI, fig. 1.
Style......	90 mm. (not perfect).	—	105 mm. (not quite perfect).	116 mm. (imperfect).	105 ? mm. (imperfect).
Stylet......	—	75 mm.	64 mm.	—	—

The following specimens belong to *C. Murchisoni:*

1. A good specimen of three segments and three caudal spines from the Wenlock Shale of Cwm-y-sul, near Welshpool, in the collection of J. Bickerton Morgan, Esq., of Welshpool.

2. A somewhat similar specimen in the Owens College, Manchester. No locality.

3. Also, in the same Museum, part of some caudal appendages marked "A. L., opposite New Bridge." Greenish calcareous mudstone. Lightbody Coll.

4. Another in Owens College is a piece of a straight ridged style, marked "U. L. Whitcliffe wd."

5. In Owens College a somewhat similar fragment in greenish, micaceous mudstone, with casts of *Beyrichia Wilckensiana* and of small *Primitiæ*, is labelled "By fish-bed; Ludford Lane."

6. Oxford Museum P is a small fragment of a telson strongly ridged, said to be from Upper-Ludlow Beds of Usk, in squeezed, imperfectly cleaved, olive-grey mudstone, with small Brachiopods.

7. Ludlow Museum T comprises the large part of a style and fragment of a stylet. From the Lower-Ludlow beds of an old roadside quarry at Trippleton Farm, one mile from Leintwardine, Shropshire. Lightbody Coll.

8. Numerous small pieces of ridged caudal spines occur in the Upper Ludlow Fish-bed: as in the British Museum Nos. 19821, 26045, 26046, 33216, 33322, I.151, &c.

3. Ceratiocaris valida, *T. R. J. and H. W.*, 1886, Pl. VI, figs. 10 and 11.

1866.	Ceratiocaris	Murchisoni,	*H. Woodward.*	Geol. Mag., vol. iii, p. 205, pl. 10, figs. 8, 9.
1877.	—	—	—	Catal. Brit. Foss. Crust., p. 71.
1878.	—	—	(part), *H. N. & E.*	Catal. Camb. and Sil. Foss., M. P. G., p. 84.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., Brit. Assoc., p. 337; and Geol. Mag., 1885, p. 388.
1886.	—	valida,	—	Fourth Rep., Brit. Assoc., p. 230; Geol. Mag., 1886, p. 456.

The caudal appendages only are known; they are very stout, curved at first downwards and then upwards. The style (about 125 mm. long) is strongly ridged and fluted, and it is pitted along two lines, one on each side. The stylets are ridged and 90 (?) mm. long. The heads of style and stylets are wrinkled lengthwise. A fragment of the ultimate segment, attached, shows that it was ornamented with straight wrinkles. The specimens from the Wenlock-beds of Dudley and Kirkby Lonsdale, described and figured in the 'Geol. Mag.,' 1866, p. 204, pl. 10, figs. 8 and 9, as belonging to *C. Murchisoni*, are too thick and strong for that species, and the Dudley example (fig. 8) has different proportions. We propose to distinguish them as *C. valida.*

Pl. VI, figs. 10, 11. Copied from the 'Geological Magazine,' vol. iii, 1866, pl. 10, figs. 8, 9. Wenlock Shale, Dudley, collected by Mr. Hollier.

Fig. 10. 'Geol. Mag.,' vol. iii, p. 204, pl. 10, fig. 8, "*C. Murchisoni*," in Dr. H. Woodward's paper "On the Occurrence of *Ceratiocaris* in the Wenlock Formation (Upper Silurian) of England." Portion of a style (telson), attached to a small piece of an ultimate segment, and two stylets, one with a sharp perfect end, the other somewhat shortened. All are grooved and ridged, and the telson bears a row of strong puncta along one side of its outer ridge. The describer writes: "The specimen from Dudley has been partially worked out on the upper edge of the slab of shale on which it rests, so as to expose both sides of the central spine (telson); and, although much flattened, it exhibits another row of punctations corresponding to that seen in the plate, and two intermediate dorsal furrows."

Fig. 11. *Op. cit.*, fig. 9. (Mus. Pract. Geol. $\frac{17}{15}$.) 'Catal. Camb. and Sil. Fos.,' 1878, p. 84. From Casterton Low Fell, Kirkby Lonsdale, Westmoreland. The section of the strata of this hill, with the Barbon Low Fell adjacent, is figured and described by Prof. T. McKenny Hughes in the 'Geol. Mag.,' vol. iii, pp. 206—208. *Cardiola interrupta* is a prominent fossil in these beds, which are equivalent to the Denbighshire Grits of the Wenlock series. Portions of telson and two stylets, all ridged; the former pitted along the side of its outer ridge.

Fig. 12. *Op. cit.*, fig. 10. (British Museum.) The head of a telson from the Silurian strata of Bohemia, showing the arrangement of two parallel rows of pits on longitudinal ridges, one on each side of the back with a median dorsal ridge between them. This may probably have been the arrangement in the English specimens, figs. 10 and 11 (and others), before they were modified by pressure.

Mr. G. J. Williams, F.G.S., of Ffestiniog, has a good, though imperfect, specimen of the caudal spines, from the Wenlock Shale of Harp Hollow, near Welshpool.

C. VALIDA.—Carapace not known. *Ultimate segment.*—Striated longitudinally. *Caudal spines.*—Thick, flexuous, ridged and fluted. *Style.*—Punctate on each side of its dorsal ridge.

4. Ceratiocaris tyrannus, *Salter, MS.*, 1878. Pl. III, figs. 2, 3, 5, 6, 8; Pl. IV, fig. 4; Pl. V, fig. 4; Pl. IX, fig. 4 (?).

1878.	Ceratiocaris tyrannus, *Salter*, MS., *H. N. & E.*		Catal. Cambr. and Silur. Foss., M. P. G., p. 118.
1884.	—	Murchisoni, *La Touche.*	Handbook Geol. Shropshire, p. 37, pl. 17, fig. 565.
1885.	—	stygia (part), *T. R. J. & H. W.*	Third Report, Brit. Assoc., p. 345; Geol. Mag., 1885, p. 396.
1886.	—	attenuata, —	Fourth Rep., Brit. Assoc., p. 230; Geol. Mag., 1886, pp. 456, 457.

Some abdominal segments (Oxford Mus. E; Ludlow Mus. L; B. M. 39403; M. P. G. $\frac{23}{35}$ and $\frac{23}{36}$), narrow in proportion to those in one other specimen marked $\frac{23}{36}$, and referred to *C. Murchisoni* (above, p. 17), and very much narrower and smaller than in *C. gigas*, we separated in 1886 as belonging to a new species called *C. attenuata*, but we find that it is the *C. tyrannus* of Salter. They have straight styles and stylets, much shorter than in either of the foregoing.

Carapace not known, unless Pl. III, fig. 8, showing a fragment occurring on the tablet marked $\frac{23}{36}$, belongs to it; if so, it is longitudinally striate. Segments narrow, ornamented with longitudinal wrinkles, which curve up and down at the anterior edge. Epimeral borders strongly defined and bearing joint-marks, either for contiguous segments or for abdominal appendages (uropods). The ultimate segment cylindrical (like others), straight-wrinkled, long, and narrow. Caudal appendages straight, sharp, and rather short; ridged and furrowed; style pitted (Pl. V, fig. 4).

In a small specimen (Pl. III, fig. 6) the stylet is 20 mm. long.; and the style was probably twice as long.

(Pl. II, fig. 4, and Pl. V, fig. 6, have caudal appendages very similar to those in Pl. III, figs. 3, 5, 6, and Pl. V, fig. 4, and possibly should be referred to *C. tyrannus* rather than to *C. Halliana;* but, taken together with Pl. IV, figs. 5 and 6, their carapaces graduate to that in Pl. II, fig. 1.)

Pl. III, fig. 2. Some segments, and part of appendages, lying at right-angles, and broken. Three body-segments shown as hollow casts. A tubercle on the lower part of the anterior third of each segment is shown by an impression in the casts. Longitudinal, wavy, irregular striæ (impressions of wrinklets) mark the segments; curving and anastomosing at the anterior or proximal edge. Parts of three caudal spines are present. Mus. Pract. Geol. Marked "$\frac{23}{36}$. Lower Ludlow; Church Hill, Leintwardine. *Ceratiocaris tyrannus*, Salter." See 'Catal. Camb. and Sil. Foss., M. P. G.,' 1878, p. 118. In olive-grey mudstone; slightly micaceous.

Pl. III, fig. 3. Four segments and crushed fragment of telson and a stylet, preserved as hollow casts, with traces of joints at the epimeral borders, as above. Mus. Pract. Geol. Marked "$\frac{23}{36}$. *Ceratiocaris tyrannus*, Salter. Leintwardine." In olive-grey mudstone. See 'Catal.,' 1878, p. 118.

Pl. III, fig. 5. A small specimen of five body-segments, and caudal appendages crushed. There is a tubercle (joint-mark) in the lower front of the penultimate segment and the next above, and fainter in the other two. There is also a half-round joint in the posterior angle (indistinct) of the penultimate segment. The ultimate segment has straight striæ. There are also faint indications of a rounded posterior angle, and of an acetabulum on the telson, crushed up; that is, there is an obscure joint-like hollow on it to fit against the lower posterior angle of the ultimate segment. The telson-head has a minute leaf-like anastomosing ornamentation, not shown in fig. 5. Mus. Pract. Geol. Marked "$\frac{23}{35}$. Wyatt-Edgell Collection. Lower Ludlow, Leintwardine. *Ceratiocaris tyrannus*, Salter." See 'Catal. Camb. and Sil. Foss.,' 1878, p. 118.

Pl. III, fig. 6. Four segments and appendages imperfect. The rounded head of telson is rather more distinct than in the figure; but no corresponding articular facet is left at the angle of the ultimate segment. Head of the stylet is apparently rounded, and more distinctly pressed into the lower angle of the ultimate segment than in the figure. Indication of a joint-socket at the lower posterior angle of penultimate segment (not in figure). Telson and stylet ridged longitudinally. The ultimate and penultimate segments show the inside of their tests. The next is a hollow cast of the outside of the shell; and the uppermost segment shows its outside.

B. M. 39403. Greenish-grey micaceous mudstone with impressions of *Discina* and other small shells (not Brachiopods), and impressions of fossil plant and Orthoceras? Lower Ludlow; Ludlow. A. Marston Coll.

Pl. III, fig. 8. This is part of a carapace-valve, longitudinally striate. Striæ very fine on the dorsal region, coarser along the middle, and coarsest along the ventral region. (On the back of this specimen is the smooth convex cast of a small right valve,[1] as small as Oxford Mus. J., Pl. IV, fig. 6, and with truncate posterior like that of Oxford Mus. K., fig. 5) Mus. Pract. Geol. Marked "$\frac{23}{36}$. *C. tyrannus*, Salter. Leintwardine." See 'Catal.,' 1878, p. 118.

In brownish-grey micaceous mudstone, like other pieces of the same $\frac{23}{36}$.

Pl. IV, fig. 4. Seven segments (convex casts with films of the test), broken-in along their upper thirds, and part of the other side shown by impressions above and beyond them. Tubercle (? joint) with hollow upper face, strong on the penultimate and the next segment, and faint on that preceding. Terminal portions of two of the caudal spines are present. The ultimate segment is pinched-up along

[1] An oblique fragment of shell imitates a tail in this little specimen.

its middle. Oxford Mus. E. "Lower Ludlow; Leintwardine." Brownish mudstone.

Pl. V, fig. 4. Four segments and two of the appendages. The four body-segments, with relics of the test, are ornamented with longitudinal and anastomosing wrinklets. The style and one stylet, imperfectly preserved, are both longitudinally ridged. The head of the telson (style), adherent at the joint to the ultimate segment, is lattice-marked; and the telson is dorsally pitted. The stylet, almost perfect, was probably about 20 mm. in length, and the style may have been about 40 mm.

In light grey mudstone; slightly calcareous. Lower Ludlow; Church Hill, Leintwardine. Marston Coll. Ludlow Museum, L. Figured in La Touche's 'Handbook of the Geology of Shropshire,' 1884, pl. 17, fig. 565.

Pl. IX, fig. 4. Imperfect segment. A portion of an abdominal segment showing the epimeral furrow and the longitudinal, inosculating, raised striæ or wrinklets, turning down at the lower corner of the anterior portion. The upper anterior corner is wanting. Magnified 4 diameters. This seems to agree with the small specimen of *C. tyrannus*, Pl. III, fig. 5. Compare also Pl. V, figs. 4 and 6 *b*; Pl. IV, fig. 4; and Pl. I, AA. Some of these are in reverse, as they belong to the other side of the abdomen. In Mr. Salwey's collection, Ludlow; on the back of the specimen with *Physocaris vesica* (Pl. VII, fig. 8); from Leintwardine.

In the Ludlow Museum the specimen marked M, from the Lower Ludlow-beds of Clunbury (?), has four segments of *C. tyrannus*, with appendages, all crushed. Also the specimen Q, from Church Hill, Leintwardine, Lightbody Coll., seems to belong to the same species, showing part of the last segment and appendages.

5. CERATIOCARIS GIGAS, *Salter, MS.*, 1865. Pl. III, fig. 1; Pl. IV, fig. 2; Pl. V, fig. 5.

1865.	CERATIOCARIS GIGAS (*Salter*),	*H. & E.*	Catal. Foss. M. P. G., p. 79.
1878.	— —	— *H. N. & E.*	Catal. Cambr. and Silur. Fossils, Mus. Pract. Geol., p. 141.
1885.	— MURCHISONI,	*T. R. J. & H. W.*	Third Report, Brit. Assoc., p. 338; Geol. Mag., 1885, p. 389.
1886.	— GIGAS,	—	Fourth Rep., Brit. Assoc., pp. 229, 230; Geol. Mag., 1886, p. 456.

The caudal appendages of *C. Murchisoni* have a slight curvature; there are others much like them, but straight and associated with a large ultimate segment,

much broader than that in M. P. G. $\frac{23}{36}$, Pl. III, figs. 2, 3. For instance, Oxford Mus. F; M. P. G. x $\frac{1}{2}$; Ludlow Mus. T. One of these (x $\frac{1}{2}$) has been labelled *C. gigas* by Mr. Salter, and therefore we adopt that name.

Only the ultimate segment and the three caudal spines are known. The former is large, being broad and strong, and is marked with longitudinal wrinkles; the latter are long, straight, and ridged. The style is strongly fluted and pitted, and its head bears the leaf- or lattice-pattern.

The characteristic fragment of this species, in the Museum Pract. Geology, marked x $\frac{1}{2}$, and labelled *C. gigas* by Mr. Salter, was entered in the 'Catalogue of Fossils,' 1865, under that name.

Pl. III, fig. 1. An ultimate segment, and upper portion of caudal appendages crushed. This segment has thin longitudinal wrinklets; and its terminal rim is regular for a part of its length. The head of the telson is bulbous, and below it the tops of the caudal spines are crushed. The telson is ridged. Mus. Pract. Geol. Marked "x $\frac{1}{2}$. Lower Ludlow; Danefield, Kington. *Ceratiocaris gigas?* Salter. Presented by J. W. Salter, Esq." See 'Catal.,' 1878, p. 141. Darkish olive-grey micaceous mudstone.

Pl. IV, fig. 2. Ultimate segment and caudal appendages. The head of a stylet is close to a semicircular acetabulum under the shoulder of the telson-head. Stylet, 55 mm. long; style probably twice as long.

Articulation between telson and lower angle of ultimate segment almost perfect. Under or inner flange at top of the telson well preserved (brown-black). Inosculating angular wrinkles on telson-head making minute leaf-marks.

Strong, raised, interrupted, inosculating, longitudinal wrinkles on the ultimate segment; also semicircular facet for the preceding segment. Oxford F. In greenish-grey mudstone, weathering brownish; calcareous at the edge, along very thin seams. Lower Ludlow.

Pl. V, fig. 5. An ultimate segment, like that of Pl. IV, fig. 2; but, though crushed, more perfect at its upper dorsal angle. The articulation for the preceding segment is well preserved. The longitudinal sculpture of anastomosing wrinklets is very distinct on this purplish specimen. Ludlow Museum T. In light greenish-grey micaceous mudstone, calcareous. Marked "Lower Ludlow; Church Hill. *C. gigas*. H. Pardoe."

Specimens corresponding in character with *C. gigas* are: 1. Ludlow Museum R, a broken ultimate and imperfect appendages, from Church Hill, Marston Coll. 2. Parts of a straight style and stylet; as a ferruginous cast. From the Upper Coldwell Beds (= Wenlock), South of Coldwell Quarry, Windermere. Cambridge Museum; Marr Collection.

Either *C. gigas* or *C. Murchisoni:* 1. Fragment of a straight, strong telson. Ludlow beds; Bury Ditches, Salop. British Museum. 2. Fragment of a caudal

spine, in hard micaceous mudstone with Orthides. Oxford Museum D. 3. A similar piece, from Church Hill, near Ludlow. In Mr. Cocking's Collection.

C. gigas is comparable with *C. Bohemica*, Barrande, 1853, 'N. Jahrb.,' and 'Sil. Syst. Bohème,' vol. i, Suppl., p. 447, pl. 19, figs. 1—13.

6. CERATIOCARIS HALLIANA, *T. R. J. and H. W.*, 1886. Pl. II, figs. 1, 2, 3, 4 (?); Pl. IV, figs. 5, 6; Pl. V, figs. 6 *a*, 6 *b* (?).

1860. CERATIOCARIS LEPTODACTYLUS, *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 157.
1865. — — *H. & E.* Catal. Foss., M. P. G., p. 79.
1878. — — *H. N. & E.* Catal. Cambr. and Silur. Foss., Mus. Pract. Geol., pp. 118, 142.
1884. — — *La Touche*. Handbook Geol. Shropshire, p. 37, pl. 17, fig. 566.
1885. — MURCHISONI (part), *T. R. J. & H. W.* Third Report Palæoz. Phyll., Brit. Assoc., pp. 337—340; Geol. Mag., 1885, p. 388.
1886. — HALLIANA, *T. R. J. & H. W.* Fourth Report, p. 230; Geol. Mag., 1886, p. 457.

One fine large carapace (M. P. G. x $\frac{1}{5}$) and others smaller and less definite in some respects (M. P. G. x $\frac{1}{7}$; x $\frac{1}{6}$; x $\frac{1}{9}$; Ludlow Mus. A; Oxford Mus. K and J), and associated with segments and appendages, we regard as distinctive of a new species, though formerly referred to *C. leptodactylus* and *Murchisoni*, M'Coy. The test, though thin, appears to have been of an unusually hard consistency.

These carapaces in some instances have been much modified by pressure, but we trace a close similarity throughout the series, allowing for probable differences of age.

The carapace (large or small) is long and smooth; pyriform, or acutely sub-ovate, deep behind, narrow in front; gently convex on the back; outlined by a bold elliptical curve on the ventral margin, which rises up to form with the dorsal edge a sharp angle in front, above the median line of the valve; but this and other features varied with age and sex, and have been modified by pressure in the different specimens. The antero-ventral margin is sometimes in-drawn, making the point in front more acute. The hinder margin is truncate with an elegant ogee curve, full below, and ending above in the postero-dorsal angle, which is often but not always sharply defined in the specimens. In some cases the ventral margin is much deeper than in others.

Five to eight segments are exposed, usually with obscure straight striæ, but occasionally retaining a more complicated wrinkling at the anterior edge (Pl. V,

fig. 6 *b*). Telson and stylets delicately ridged; the former pitted, and its head obscurely wrinkled (Pl. II, fig. 4).

The shape of the carapace approximates to that of Dr. James Hall's species *C. acuminata* and F. Schmidt's *C. Noetlingi* ('Third Report, Brit. Assoc.,' p. 355). There are marked differences, however, and we have designated this form *C. Halliana,* in honour of our old and valued friend, who began working at these Phyllocarida as early as 1852.

A perfect specimen of *C. acuminata,* Hall, has been described and figured by Dr. Julius Pohlman in the 'Bulletin of the Buffalo Society of Natural Sciences,' vol. v, No. 1, 1886, pp. 28, 29, pl. 3, fig. 2. Its caudal appendages are much like those of *C. papilio* and *C. stygia,* the style being relatively short, and the stylets broad and blade-like. The appendages in M. P. G. x $\frac{1}{7}$, x $\frac{1}{9}$, and Ludlow Mus. A, are different from these, being thinner, tapering slowly, and pitted in at least one row, as seen exposed.

The specimens under notice are probably the same as those which Mr. Salter apportioned to *C. leptodactylus*—" Cephalothorax long, triangular, acute in front, broad and rounded behind. Free abdominal segments 7 to 8 in number, subquadrate, deeply impressed at the sides. Caudal appendages long, striate; the central spine (telson) scarcely thicker than the long lateral spines. Surface of carapace smooth, or marked with only very short sparse lines. Abdominal segments strongly striate. The whole animal elongate and more than a foot long." ('Annals Mag. Nat. Hist.,' ser. 3, vol. v, 1860, p. 157.) One particular specimen in the Mus. Pract. Geol. is referred to by Mr. Salter at p. 158 (perhaps Pl. II, fig. 2 or fig. 4). We are at a loss in fitting the indicated slender appendages of *C. leptodactylus* to the carapace above described. We have examined the above-mentioned and other good specimens, labelled *C. leptodactylus* by Mr. Salter, or at his direction, in which the *carapace* agrees with his description. One carapace is of large size, nearly perfect, about 125 mm. (5 inches) long, by 55 mm. at greatest height; M. P. G. x $\frac{1}{5}$, Pl. II, fig. 1. A specimen nearly perfect, M. P. G. x $\frac{1}{7}$, 60 mm. long by 28 mm., gives no certain indication of the length of its telson and its two stylets, for they are crushed off short (Pl. II, fig. 2). The abdomen exposed is about 50 mm. in length.

There is also a well-preserved *small* specimen, M. P. G. x $\frac{1}{9}$, with its carapace measuring only 25 mm. in length and 11 mm. in height, from the Lower Ludlow of Bow Bridge, Ludlow (Pl. II, fig. 4). This is labelled " *C. leptodactylus*," but belongs to the same species as the foregoing. Its caudal appendages are perfect, with the telson (25 mm.) about one third of the length of the whole animal; and they differ from M'Coy's *C. leptodactylus* in their proportions.

Pl. II, fig. 4 and Pl. V, fig. 6 may possibly belong to *C. tyrannus*, for their caudal appendages agree with some referred to that species (see p. 22). For con-

venience, however, we have kept together those having carapaces; especially as these appear to graduate in shape from the very small specimens Pl. IV, figs. 5 and 6, to the large one Pl. II, fig. 1.

Pl. II, fig. 1. Carapace showing the left valve. This large carapace is imperfectly preserved, but shows all its shape, except that the anterior angle has been broken off. The valves are very thin; a portion of the left valve is present; and the right valve is represented in part by an impression of its outside; and its remainder is covered by the compressed layer of matrix which lies between the two valves, and the broken edge of which is exposed along the middle of the specimen. The valves were apparently quite smooth, and are slightly crumpled by pressure; the portion preserved is traversed by fine cracks, along and athwart, causing it to break into more or less quadrangular pieces.

Mus. Pract. Geol., marked "x $\frac{1}{5}$. Lower Ludlow; Church Hill, Leintwardine. *Ceratiocaris leptodactylus*, M'Coy." See 'Catal. Cambr. and Silur. Fossils, M. P. G.,' 1878, p. 142. In olive-grey mudstone,[1] weathering brownish.

Pl. II, fig. 2. Carapace, five or six abdominal segments, and part of the caudal appendages. Right valve shown, smooth, glazy, very thin, crumpled into irregular longitudinal folds, and breaking into small angular pieces. The posterior edge has been misshapen by pressure on the internal body-segments. The exposed segments are much crushed, but six are recognisable; the four above the penultimate retain their lower edges (though broken); and traces of a longitudinal striation are present here and there in all. The attachment of the style (telson) is obscure; also the individuality of the style and stylets. The presence of the teeth is indicated by minute mamillary projections in the anterior third of the valve. The front angle of the valve has been damaged. In the matrix beyond it is an irregular row of little pits, which seem to be the casts of small, short, hollow, ring-like bodies, possibly the remnants of some part (antenna?) of the animal protruded from the valves; or they may be some bodies altogether distinct.

Mus. Pract. Geol., marked "x $\frac{1}{7}$. Lower Ludlow; Leintwardine. *Ceratiocaris leptodactylus*, M'Coy. Presented by A. Marston." See 'Catal. Cambr. and Sil. Foss.,' 1878, p. 142. In olive-grey, micaceous mudstone, weathering brown. Some casts of small Rhynchonella-like Brachiopods lie in the matrix.

This may be the specimen referred to by Mr. Salter in the 'Ann. Mag. Nat. Hist.,' March, 1860, p. 158.

Pl. II, fig. 3. Carapace and four or five segments. This specimen is chiefly an impression, but with some films of the test, showing a right valve, smooth (glazy), but wrinkled by pressure along the ventral margin. The maxillæ are indicated by their mark within the valves. Five abdominal segments, much crushed,

[1] Some of the mudstone, containing the specimen of *Ceratiocaris* from Ludlow, is calcareous, especially in very thin seams at the edges of the slabs.

are shown. The one next the valve is broken by a crack in the stone. Some others (five ?) have left a faint trace within the carapace.

Mus. Pract. Geol., marked "x $\frac{1}{6}$. Lower Ludlow; Leintwardine. *Ceratiocaris leptodactylus,* M'Coy." See 'Catal.,' 1878, p. 142. In olive-grey micaceous mudstone.

Pl. II, fig. 4. Carapace, five or six segments, and the caudal appendages. The carapace is small (25×12 mm.), and shows its left valve. The valve is smooth, but crumpled lengthwise, and wrinkled in the ventral region. The maxillæ are indicated by pressure in the anterior third. The abdominal segments are crushed, and, being defective in their upper and lower margins, therefore look narrower than they were originally. There are traces of longitudinal striation on all the segments. The style is 25 mm. long, minutely ridged, and rugose; this roughness being due probably to decomposition, but partly perhaps to having been originally tuberculate or spined. There are two stylets, much shorter than the telson, unequally preserved, and close together; one is about 12 mm. long.

Mus. Pract. Geol., marked "x $\frac{1}{9}$. Lower Ludlow; Bow Bridge, Ludlow. *Ceratiocaris leptodactylus,* M'Coy. Presented by A. Marston." See 'Catal.,' 1878, p. 142. In olive-grey micaceous sandstone, with small Brachiopods and Orthoceras.

Pl. IV, fig. 5. Small carapace and two segments. The former apparently smooth, but bearing obscure longitudinal striæ in the postero-dorsal region. Thickened with obscure internal contents. Segments passing up apparently to the anterior third (upper side). Young (?). Oxford Mus. K. Lower Ludlow. In brownish-grey mudstone.

Pl. IV, fig. 6. Very small carapace and six segments. Probably two valves, wrinkled by pressure; no striæ visible. Obscure organic contents. Six exposed segments shown as flat casts,—portions of the test on the last two longitudinally striate. Young (?). Oxford Mus. J. Lower Ludlow. Olive-grey mudstone.

Pl. V, figs. 6 *a*, 6 *b*. Carapace, eight segments, and caudal appendages. Carapace, with its right valve outwards, smooth, crushed, and somewhat crumpled along the ventral region. Anterior extremity frayed out. Indications of internal organs in the front part. Eight body-segments crushed and broken; one of them (sixth from the end) has the epimeral border preserved with its neat sculpturing, partly longitudinal, and partly interlacing or lattice-like (fig. 6 *b*). Articulations (for uropods ?) are present on the lower portions of some segments. Telson and stylets imperfectly preserved; the former pitted with prickle-bases. Some small scattered dark spots occur on the stone beneath the anterior end of the carapace, and these may have been fragments of some of the internal organs.

In hard greenish-grey mudstone, with small Brachiopods; calcareous. Lower

Ludlow. Ludlow Museum A, marked "*C. leptodactylus,* Marston Coll." This is figured in La Touche's 'Handbook Geol. Shropshire,' 1884, pl. 17, fig. 566.

C. Halliana.—*Carapace.*—Long, sub-triangular, pyriform.
Body-segments.—With straight striæ.
Caudal appendages.—Delicately ridged; *style* pitted.

7. Ceratiocaris Pardoëana, *La Touche*, 1884. Pl. V, figs. 1 and 2.

1884. Ceratiocaris Pardoensis (part), *La Touche.* Handbook to the Geology of Shropshire, p. 77, pl. 17, fig. 563.
1885. Ceratiocaris Murchisoni (part), *T. R. J. & H. W.* Third Report, Pal. Phyll., p. 337; Geol. Mag., 1885, p. 388.
1886. — Pardoëana, *T. R. J. & H. W.* Fourth Report, p. 230; Geol. Mag., 1886, p. 457.

Two carapaces with segments and parts of appendages from Ludlow (Ludlow Mus. B and D) differ from any other form. One of them (B), with a wrong caudal appendage (Pl. V, fig. 3, p. 19) attached to it, in the Ludlow Museum, has been labelled "*C. Pardoensis,*" and as such is referred to in the Rev. J. D. La Touche's 'Handbook to the Geology of Shropshire.' We retain this name (altering the termination, as it refers to a person, and not a place) for the two carapaces here referred to. One of them (B) is of special interest as having its *rostrum* nearly in place (Pl. V, fig. 1).

In specimen D of the Ludlow Museum (Pl. V, fig. 2), which has the proximal portion only of the caudal spines preserved, and in specimen B, with the appendages also broken off short, the telson was ribbed and pitted (= prickly).

Carapace subovate, broad, and short; smooth (?), pitted (fringed) on ventral rim; pointed medially in front; truncate with ogee curve behind. Rostrum present in Pl. V, fig. 1. Segments, six, exposed. Ultimate segment long; all delicately wrinkled longitudinally. Style and stylets ridged; the former pitted.

Pl. V, fig. 1. Carapace, five or six abdominal segments, and part of the caudal spines. The right valve lies outwards, showing part of the moulded matrix between the valves and some relics of indistinguishable body-substance. Four segments preserve their shape (compressed) and test; and are continued inwards with indications of three others within the carapace. The intestinal tube is traceable from the posterior margin of the carapace to the lower angle of the ultimate segment. Longitudinal, sinuous, anastomosing wrinklets ornament the

surface of the segments. The proximal portion of the crushed caudal appendages is present; the telson is punctate with the bases of prickles along its dorsal edge.

In a green-grey, rather hard mudstone; calcareous throughout, but less in some parts than in others. Lower Ludlow; Church Hill, Leintwardine. Ludlow Museum B. Pardoe Coll.

Pl. V, fig. 2. Carapace, five or six segments, and part of the caudal appendages. A smooth, but crumpled carapace (left valve outwards), with obscure indications of internal organs, and a faint trace of an antenna (?) at its front apex. Five body-segments, partly crushed, some showing longitudinally wrinkled and anastomosing sculpture. Proximal portion of the style and two stylets is present; the style bearing a row of little pits (closer and rather more numerous than in the figure).

In greenish-grey micaceous mudstone, calcareous on the edge, weathering brownish, and bearing some impressions of small Brachiopods, with numerous spots and patches of organic origin. Lower Ludlow. Ludlow Museum D. Lightbody Coll.

C. Pardoëana.—*Carapace.*—Subovate, pointed in front, with *rostrum.*
Body-segments.—Delicately striate longitudinally.
Caudal appendages.—Strong, ridged; the *style* pitted dorsally.

8. Ceratiocaris canaliculata, *T. R. J. and H. W.*, 1886. Pl. IX, figs. 2 and 3.

1886. Ceratiocaris canaliculata, *T. R. J. & H. W.* Fourth Report on the Palæozoic Phyllopoda, Brit. Assoc., p. 230; and Geol. Mag., October, 1886, p. 457.

Two small specimens showing crushed telsons (one in Mr. Cocking's collection, and the other M. P. G. x $\frac{1}{28}$; both from the Ludlow series). These are rather stout and ridged, and have a fluted or channelled sculpture on their upper part, instead of either wrinkles or leaf-pattern; hence we have given the name *canaliculata.* The ultimate segment bears straight striæ (fig. 3).

Pl. IX, fig. 2. The upper portion of a much crushed and broken telson, reddish-brown, ridged, and bearing straight, low, rather broad wrinkles at its proximal end, and indications of the bases of bristles (pits) on its outer edge (displaced by crushing).

In rather soft, light-greenish grey, micaceous, and calcareous mudstone. Upper Ludlow Beds; Whitcliffe, Ludlow. Mr. Cocking's Collection.

Pl. IX, fig. 3. Part of an ultimate segment and caudal appendage (telson) crushed and imperfect. The former shows strong, sharp, longitudinal, inoscu lating wrinklets; the latter, consisting of a broken telson, ridged and furrowed, shows at its articular or proximal end nearly straight, feeble, but rather wide wrinkles running down into the ridges, as in fig. 2.

In the Museum of Practical Geology, marked x $\frac{1}{28}$. Grey mudstone, brownish on one face, greenish elsewhere, finely micaceous, and partially calcareous; with casts of Polyzoa, small Brachiopoda, &c. Upper Ludlow Beds; Whitcliffe, Ludlow (old wall). Collected by Mr. Lightbody.

9. Ceratiocaris Ludensis, *H. Woodward*, 1871. Pl. I, and Pl. IX, figs. 1 *a*, 1 *b*.

1871. Ceratiocaris Ludensis, *H. Woodward.* Geol. Mag., vol. viii, p. 104, pl. 3, fig. 3.
1884. — — *Jones and Woodward.* Geol. Mag., dec. 3, vol. i, p. 396.
1885. — — *T. R. J. & H. W.* Third Report Palæoz. Phyll., Brit. Assoc., p. 341; Geol. Mag., dec. 3, vol. ii, No. 9, September, 1885, p 392.
1886. — — *T. R. J. & H. W.* Fourth Report, p. 230; Geol. Mag., dec. 3, vol. iii, p. 457.

This large and indeed gigantic *Ceratiocaris*, represented by seven abdominal segments, with the caudal appendages of telson and two stylets, in the Ludlow Museum, was described in the 'Geol. Mag.' for March, 1871, and illustrated with a reduced figure. The carapace is there estimated as having probably been eight inches in length. The segments giving eight inches, and the telson having been probably more than nine inches in length (possibly much more, see p. 34), the animal was more than two feet in total length. As pointed out in the paper referred to, the telson, as estimated, is certainly the longest known; for we find the relative proportions to be—for *C. Ludensis*, H. W., 144; *C. Murchisoni* (Agass.), 128 (as defined above); *C. Deweii* (J. Hall), 100; *C. Bohemica,* Barr. (Brit. Mus.), 84; *C. stygia*, Salter, 32; *C. Nœtlingi*, F. Schmidt, 26; *C. papilio*, Salter, 16.

The segments are ornamented along the back with imbricated or lattice-like raised angular lines, which pass downwards on the sides into oblique and then curved wavy lines, and these form an irregular reticulation at the anterior margin. The ultimate segment was cylindrical, and is striated longitudinally with interrupted and inosculating lines. The caudal spines are stout, tapering slowly, slightly curved inwards (downwards), and delicately ribbed; and one bears some marks of the bases of setæ or prickles (F, in Pl. IX, fig. 1 *a*).

This fine specimen is from the laminated mudstone of the Lower-Ludlow series, at Church Hill, Leintwardine, near Ludlow, associated with Graptolites. It was obtained many years since by the late Mr. H. Pardoe, and is preserved in the Ludlow Museum.

On careful examination of this large specimen of *C. Ludensis*, H. W., we have reason to believe that the caudal appendage which appears longest in the fossil was not really the longest, or the true telson, but was one of the "laterals" or stylets. Hence the whole animal was probably much longer than our first estimate made it.

Pl. I. *Ceratiocaris Ludensis*, H. W. (Ludlow Museum.) Two thirds of the natural size. (See also a portion, in Pl. IX, of the natural size.) Leintwardine. Greenish-grey, hard, micaceous, calcareous mudstone, with many small Graptolites (*Monograptus priodon*), nearly all lying in one direction. There are also other little marks of organic origin, and a few obscure impressions of larger fossils.

Seven abdominal segments (A and B) and three caudal appendages (C—G). The former are laterally compressed; the latter much damaged by breakage of the stone. Six segments (A) have an ornament of raised wrinklets, longitudinal and inosculating, but turning up and down on the anterior third. The seventh, or ultimate segment (B), has only longitudinal wrinklets, interrupted and inosculating. The opposite sides of five segments, A, are figured at AA, showing their epimera; and the opposite sides of the penultimate (part of A) and the ultimate (B) segments, taken out from their embedment (being loose), are shown at BB.

At C (in intaglio) and CC (in relief) is seen the distal end of what appears (at first sight) to have been the longest of the caudal spines, smooth and depressed for the distance of half an inch from the end; then bearing three ridges, besides the half-buried thick edges; and at first slightly, and then strongly marked by successive constrictions across the ridges, so as to present a series of several, nearly equal, ridged tubercles, set more or less obliquely across the spine. These bear no definite marks of pitting. See Pl. IX, fig. 1 *b*, for an enlarged view of this piece.

In the next portion upward (D) of this caudal spine the outside has quite gone, and the internal structure is obscure. A small piece of what appears to be a smooth, ridged, caudal spine appears (not seen in Pl. I) in the stone near this part, at a higher level, and almost in a line with another caudal spine (F). What remains of the upper or proximal end (E) of the caudal spine C, D, is partly convex, and roundly truncate, ending apparently with such a joint as the stylets or lateral caudal spines have at the top. Downwards it has been squeezed flat, showing obscure lumpy ridges and confused internal structure. For about an inch before it is concealed by the matrix (D) it is modified by another fossil (fragment of *Eurypterus ?*) having lain across it.

This caudal spine (C, D, E) seems, from the apposition of its rounded top to

the hollow or socket of an articulation in the larger caudal spine lying closely above it, to have been a lateral or stylet. If so, its length ($7\frac{3}{4}$ inches, though imperfect) indicates a very great size for the whole animal, since the median or chief caudal spine (style or telson) must have been much longer. Its relative position at present can be accounted for by supposing it to have been pressed obliquely outwards, so as to have been displaced backward.

At F a piece of a caudal spine is seen separate from, and at a different level from that of E, but showing obscurely the same kind of lumpy surface as at C, C; and higher up with a few obscure, minute, oval areoles with central pimples, or prominences for the attachment of prickles.

At G is the badly preserved upper end ($1\frac{3}{8}$ inch) of a caudal spine (probably the telson or style) distinct from and at a different level to the others (E and F). It is broader than either of the other two. Its proximal end widens out ($\frac{1}{2}$ inch) before it is damaged and broken through, and thereby divided from what may be its top portion, which is in apposition (with a joint) to the ultimate segment. It retains (below the fracture) the curved socket for one of the laterals or stylets.

Unfortunately, nothing of the other extremity of this large spine (G) is to be seen in the further part of the stone.

Pl. IX, figs. 1 *a*, 1 *b*. *Ceratiocaris Ludensis*, H. W., as in Pl. I, but not reduced.

Fig. 1 *a*. The impression of the penultimate and ultimate segments in the matrix, and the caudal appendages, all of the natural size. The former show the impressions of the raised wrinklets on the matrix, and some portions of the inside of the test with its sunken striæ, or backs of the wrinklets; also the articulation (somewhat crushed) of the head of the telson, and below, broken off, the remnants of the three large caudal spines, figured two thirds natural size in Pl. I, and described at p. 33. The outer (right hand) seems, at first glance, to be the style, but very possibly the inner one (on left hand), though not in its natural position, may have been really the large, median spine or telson. The articulation above probably belonged to it; especially as a socket under its shoulder seems to be fitted by the head of the outer spine. This latter, and the more obscure third spine, may well have been the lateral spines thrown out of position by pressure.

Under these circumstances the length of the main caudal appendage (telson or style) cannot be ascertained, and it may have been at least more than half as long again as the lateral spine, which measures $7\frac{3}{4}$ inches.

Fig. 1 *b*. The lower portion of the spine marked C, enlarged twice. (See also Pl. I, C.)

10. CERATIOCARIS PAPILIO,[1] *Salter*, 1860. Pl. XI, figs. 4 *a*, 4 *b*, 6; Pl. XII, fig. 1.

1859. CERATIOCARIS, *Salter*. In Murchison's Siluria, 2nd (3rd) edit., p. 262, woodcut, fig. 1, p. 538.
1860. — PAPILIO, *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 154, woodcut, fig. 1, and p. 155.
1865. — — *Salter and H. Woodward*. Catal. and Chart Foss. Crust., p. 17 (not fig. 5).
1865. — — *H. Woodward*. Geol. Mag., vol. ii, p. 403, pl. 11, figs. 1 and 2.
1865. — — *H. & E.* Catal. Foss. M. P. G., p. 79.
1867. — — *Salter*. In Siluria, 3rd (4th) edit., p. 236, woodcut, fig. 1 (not fig. 2), and p. 516.
1873. — — — Catal. Camb. and Sil. Woodw. Foss., p. 178.
1873. — — *R. Etheridge, jun.* Mem. Geol. Surv. Scotl. Expl. Map 23, pp. 55, 56.
1876. — — *Armstrong and others*. Catal. W.-Scot. Fossils, p. 24.
1877. — — *H. Woodward*. Catal. Brit. Foss. Crust., p. 71.
1878. — — *Huxley, Newton, and Etheridge*. Catal. Camb. and Sil. Foss., p. 142.
1885. — — *T. R. J. & H. W.* Third Report Pal. Phyll., p. 341; Geol. Mag., 1885, p. 392, pl. 10, fig. 1.
1886. — — — Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

We have not yet by any means exhausted the study of *C. papilio* and *stygia*. We know, however, that the abdominal segments in both were delicately sculptured with leaf-like or lattice-pattern ornament, as in some other species, the points of the triangles pointing upwards, or rather backwards, towards the carapace, and one limb of the triangle, where free, running downwards and outwards in the other direction. These oblique lines are often visible when the triangles have disappeared from wear or decomposition. Among many others the segments M. P. G. x $\frac{1}{17}$; B. M. 41900: Oxford Mus. A and H exhibit fine examples of this leaf-like ornament; and it is visible in several more complete individuals in those collections. In the Braidwood, Glasgow, and Edinburgh Museums numerous specimens (chiefly *C. stygia*) show it well.

Of the two species, so abundant in the Lower Ludlow Shales of Logan

[1] Of this species and *C. stygia* we have more material at our command than we have been as yet able to figure and fully describe. We rest content at present with Pl. XII and the few other figures, intending to give illustrations and detailed descriptions of other and better specimens further on.

Water, near Lesmahago, in Lanarkshire, and described (unfortunately without good figures) by J. W. Salter in the 'Ann. and Mag. Nat. Hist.' for March, 1860, we have examined many good specimens. As mentioned by Salter, one (*C. papilio*) has the carapace more oblong than the other (*C. stygia*), which is deepened by a greater or less angularity on its ventral margin. In the woodcut diagrams at p. 154 of his memoir, fig. 1 is the oblong form, and figs. 2 and 3 have the deep ventral angle (*C. stygia*), and yet they are all three termed *C. papilio*, evidently from oversight. In the Lesmahago district multitudes of the two species seem to have been embedded in the black mud (now shales); and frequent references to these interesting deposits are made in 'Siluria,' 'Memoirs of the Geological Survey of Scotland' (especially 'Explanation of Map 23,' p. 49, &c.), in other works on Scottish geology, in geological manuals, &c., and in Dr. J. R. S. Hunter's papers in the 'Trans. Geol. Soc. Glasgow,' vol. vii, pp. 56, 272, &c.

In *C. papilio* the carapace is sub-oblong, straight on the back, gently curved below, like the prow of a boat in front, and truncate with an ogee curve behind. The anterior extremity is rather sharp and is rarely preserved; it slopes with a gentle curve downwards and backwards from the antero-dorsal angle to the ventral margin. The latter is somewhat convex in outline, with its greatest fulness rather forward, but near the middle; varying, however, with every specimen, all being more or less squeezed out of their true shape. The front moiety usually keeps its shape more truly than the posterior region, of which sometimes the dorsal angle (as in Brit. Mus. 41896, 41897), and sometimes the boldly-curved ventral portion (as in Brit. Mus. 41894, 58669; Cambridge Mus. *b*/135; and M. P. G. x $\frac{1}{15}$), becomes the more prominent. The surface of the valves is delicately striate, with longitudinal lines, curving parallel with the ventral margin, and coarser below than near the back. In some specimens the lines are seen to converge at (or rather, as it were, to start from) the postero-dorsal angles. The ventral margin is rimmed, and often beset with the bases of former setæ. The body-segments are leaf-marked and obliquely striated. The telson (style), relatively stout, and not much longer than the laterals or stylets, is faintly ridged, and was perhaps prickly or spinose. The whole adult animal was probably from four to six inches long.

Having seen but few specimens in which the caudal appendages are well preserved in their place, we get but few good measurements.

Mr. Salter says that only three or four of the abdominal segments were free (external to the carapace); but probably there were even five; for in one specimen (Brit. Mus. 58669; Pl. XII, fig. 1) five segments of large size, now loose and reversed, were probably exposed beyond the carapace; and in another (Brit. Mus. 41895) four, with an imperfect fifth, have been shifted out of place. The segments, excepting the last one, appear in their compressed condition to be half as long as high, and the last one as long as three of the others.

In Brit. Mus. 41894, the carapace is 60 mm. long by 30 mm. deep (or high), and probably once rather deeper, having suffered from pressure. The penultimate segment is 10 mm. long, and if there were four of that length (40 mm.), with the ultimate segment (unusually long) the body-rings would be nearly 80 mm. The telson was 25 mm. (stylets 18 mm.). Thus, altogether, the animal was about 152 mm., or six inches, in length.

Brit. Mus. 58669 (Pl. XII, fig. 1) has a longer (narrowed) carapace, five body-rings, and a broken telson; altogether, six and a quarter inches long.

In another, but smaller individual (Brit. Mus. 41895), the carapace 40×20? mm.; segments 40 mm., but shortened; and style about 20 mm. (stylets 15 mm. each), make about 100 mm., or four inches, of total length.

A specimen at Glasgow has the carapace 50 mm. long, five segments 35 mm., and the style about 25 mm. At Braidwood there is a specimen with the carapace 83 mm. long. Of twelve good specimens from Lesmahago we have seen two consisting of carapace only; and in all the others the body-portion is more or less shifted, and in seven of them it is quite reversed—that is, lying at the anterior instead of the posterior end, as described by Mr. Salter ('Ann. Mag. Nat. Hist.,' ser. 3, vol. v, 1860, p. 154; and 'Siluria,' 1867, p. 236, &c.).

The specimen Cambridge Museum *b*/36 (from Benson Knot; "*C. inornatus*, M'Coy," Salter's 'Catal. Camb. and Sil. Foss. Woodw. Coll.,' 1873, p. 178) is the penultimate and ultimate segments, with style and stylet, not crushed, but well preserved in shape, although without ornament (Pl. XI, fig. 1), of either *C. papilio* or *C. stygia*, judging from its proportions.

Of *C. papilio*, good specimens from Lesmahago:[1]

Cambridge Mus. *b*/135, with the rostrum lying at an angle across the anterior extremity. M. P. G. x $\frac{1}{15}$, x $\frac{1}{22}$. Brit. Mus. 41894, 41895, 41896, 41897, 45161, 47989, 58669. Also one in the Museum of the University of Glasgow, and one at least in the Braidwood Museum (from Shanks Castle; Dr. J. R. S. Hunter).

We have seen also some fossil carapaces from Benson Knot, Kendal (Upper Ludlow), which agree perfectly in form and proportions with *C. papilio* from Lesmahago, also in ornament, except that the postero-dorsal convergence of the striæ is not present. These are some of those marked 44342 in the British Museum; M. P. G. x $\frac{1}{4}$ ('Catal.,' 1878, p. 141). They range from 65 mm. long and 32 mm. high to 75×40 mm. Also a large imperfect specimen and some fragments in brown shale from Linburn, near Muirkirk (Brit. Mus., all marked 58878).

Moreover, the specimen N in the Ludlow Museum has the proportions and appearance of *C. papilio*, as far as it is preserved (wanting the antero-dorsal angle), from Church Hill, Leintwardine.

[1] For an account of the Geology of Lesmahago, see H. Woodward's 'Monograph of the Merostomata,' Pal. Soc., 1866, pp. 46—53.

Pl. XII, fig. 1. British Museum, No. 58669. In the black Upper Silurian shale of Lesmahago, Lanarkshire (Slimon Collection).

Two valves, delicately striate; shifted and squeezed; the right valve uppermost. With five body-segments at the anterior, instead of the posterior end. Style and stylets broken and displaced.

B. M. 41900 (Pl. XI, fig. 6) and 41901 (counterpart), Lesmahago. Three abdominal segments, lattice-marked and obliquely striate, and an ultimate segment with both oblique and straight striæ, probably due to two layers of the test. Telson, 30 mm. long; and two ensiform stylets, each about 13 mm. long. Pressed flat in slightly calcareous black shale.

Also Oxford Mus. H. (Pl. XI, figs. 4 *a*, 4 *b*) with four segments, style 30 mm., and stylet 15 mm., pressed sideways, in olive-grey shale; Ludlow (?).

It is possible that *C. papilio* may have been the *male*, and *C. stygia* the *female* of the one species.

11. Ceratiocaris stygia, *Salter*, 1860. Pl. X, figs. 7 *a* and *b*; Pl. XI, figs. 1, 3, and 7; Pl. XII, figs. 2 *a*, 2 *b*.

1859. Ceratiocaris, *Salter*. In Murchison's Siluria, 2nd (3rd) ed., p. 262, woodcut fig. 2.
1860. — stygius, *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 154, woodcut figs. 2, 3 (fig. 1 is *C. papilio*).
1865. — — *H. & E.* Catal. Foss. M. P. G., p. 79.
1865. — papilio, *Salter and Woodward.* Cat. and Chart Foss. Crust., p. 17, fig. 5.
1867. — stygius, *Salter*. In Siluria, 3rd (4th) ed., p. 236, woodcut fig. 2, and p. 517.
1873. — — — Cat. Camb. and Sil. Woodw. Foss., p. 178.
1873. — — *R. Etheridge, jun.* Mem. Geol. Surv. Scotl. Expl. Map 23, pp. 55, 56.
1876. — papilio, *F. Roem.* Leth. geogn., Th. i, Leth. Pal., pl. 19, fig. 4.
1876. — stygius, *Armstrong and others.* Cat. W.-Scot. Fossils, p. 24.
1877. — — *H. Woodward.* Catal. Brit. Foss. Crust., p. 73.
1878. — — *Huxley, Newton, and Etheridge.* Cat. Camb. Sil. Fossils, p. 142.
1885. — — *T. R. J. & H. W.* Third Report Pal. Phyll., p. 343; Geol. Mag., 1885, p. 394, pl. 10, figs. 2 *a*, *b*, *c*.
1886. — — *T. R. J. & H. W.* Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

Carapace-valves trapezoidal; back straight, but curving down for a short distance to the mucronate dorsal angle of the anterior edge, which then slopes, with a slight convexity and at a sharp angle, downwards and backwards, to about the middle of the ventral margin, where the valve is deepest (highest); the other half of the ventral edge rises slowly with a straight or nearly straight oblique edge to the blunt postero-ventral corner, whence the truncate hind margin rises, with a gentle concave curve, to the sharp postero-dorsal angle. When the valves are spread open a triangular space is left between the antero-dorsal angles. This condition and the shape are well shown in the outspread specimen M. P. G. x $\frac{1}{13}$. Fig. 2 *a* is taken from a less trapezoidal specimen. The outline is often modified by pressure in other positions, but not to quite so great an extent, as the shape of *C. papilio* is altered by squeeze in some instances. The valves are delicately striate, with longitudinal lines curving parallel with the ventral edge, and crowded at the postero-dorsal angles. The lower margin has a slightly thickened rim and is often marked with the bases of former setæ. The body-segments, of which probably five were outside the carapace (though often the segments seem to have been pushed back within the carapace after death), are marked with delicate, raised, oblique wrinkly lines on the sides, and ornamented on the back with a leaf-like pattern, or lattice-work, formed by an imbrication of angular lines, which pass down into the lateral oblique wrinkles. These joints are sometimes more than twice as high as long. The last one is usually as long as three of the others. The telson is apparently in some cases about half as long again as the stylets (as fifty is to thirty); and some specimens show traces of thin costulæ, and perhaps of prickles. The whole adult animals were from four to eight inches long.

In both *C. papilio* and *C. stygia* the caudal spines are broad and taper quickly; but the stylets are broader and shorter than the style. In *C. stygia* the style is usually rather more than twice, and in *C. papilio* only about twice as long as the ultimate segment.

Specimen M. P. G. x $\frac{1}{20}$ has the rostrum and maxillæ squeezed out loose near the front end of the carapace. A large individual, Cambridge Mus. *b*/65, measures—

Carapace		83×55 mm.	198 mm., or nearly 8 inches.
Four segments . .	40	65 mm.	
Last segment . . .	25		
Telson		50 ,,	

A small specimen, M. P. G. x $\frac{1}{13}$, measures—

Carapace		40×26 mm.	About 100 mm., or nearly 4 inches.
Four segments . .	20	30 mm ?	
Last segment . . .	10 ?		
Telson		30 ,,	

C. stygia was rather larger than *C. papilio;* its telson was larger; the carapace is markedly distinct by its trapezoidal outline, deep ventral region, and mucronate antero-dorsal angle, which was not nearly so often lost in fossilization as the front angle of *C. papilio.* In its rostrum, maxillæ, superficial ornament of carapace and of body-rings, it seems to have closely resembled *C. papilio.* In twenty-two good specimens from Lesmahago, two are simply carapaces; seven have body-segments in place and thirteen have them shifted or reversed. In this respect *C. stygia* seems to have been scarcely less liable to the dissolution of the membranous attachments of the body than its associate *C. papilio.*

A postero-dorsal fragment in Cambridge Museum (Marr Coll.), from the Denbighshire series (Wenlock), at Dinasbran, Llangollen, showing fine striæ above and coarse striæ below, and the usual convergence of striæ, belongs probably to *C. stygia.*

An anterior moiety of a valve, probably of *C. stygia* (from near Ludlow ?) is in the Grindrod Coll., Oxford Mus. G.

Good specimens of *C. stygia* from Lesmahago are Cambridge Mus. *b*/136, *b*/65 (the last is referred to as *C. papilio*, evidently by mistake, in the 'Catal. of the Cambrian and Silur. Fossils of the Woodw. Coll.,' 1873, p. 178); M. P. G. x $\frac{1}{13}$, $\frac{1}{14}$, x $\frac{1}{16}$, x $\frac{1}{19}$, x $\frac{1}{20}$, x $\frac{1}{21}$; and B. M. 41898, 45154, 45155, 45156.

In the 'Mem. Geol. Surv. Scotl. Expl. Map 23,' 1873, at p. 49, Mr. R. Etheridge, junr., enumerates the places near Lesmahago and Muirkirk, in Lanarkshire, where *Ceratiocarides* have been found by the Surveyors, namely—

Ceratiocaris papilio, Salter, at Dunside (Logan Water), Eaglinside Burn, Logan Water (2 miles south of Lesmahago), and Linburn.

Ceratiocaris stygia, Salter, at Kip Burn (Logan Water), Eaglinside Burn, and Linburn.

Ceratiocaris, caudal appendages, at Long Burn (Logan Water), Dunside (Logan Water), Logan Water (6 miles south-west of Lesmahago), Lann Burn, and Douglas Water.

There are some fine specimens of *C. stygia* in the Glasgow University Museum and the Geological Survey Museum, Edinburgh, from Lesmahago; very many in the Braidwood Museum (Dr. J. R. S. Hunter); and a few also in the Edinburgh University Museum, all from the same district. We have not yet been able to have a selection from these figured for the Palæontographical Society, but we hope to do justice to them before long and to some possibly new species associated with them.

Abdominal segments and appendages probably belonging to *C. stygia* are:

B. M. 58878, Linburn, Muirkirk. A telson, not quite perfect at base, 35 mm. long, associated with some obliquely-striate segments.

B. M. 41899, Lesmahago. Four segments, 27 mm., and M. P. G x $\frac{1}{25}c$,

four segments, 30 mm., and in each case two short ensiform stylets attached (style wanting).

Pl. XI, fig. 3. Mus. Pract. Geol., x $\frac{1}{17}$, 1 ('Catal. Camb. Sil. Foss.,' 1878, p. 142, *C. robustus*). Lower Ludlow; Leintwardine. In hard olive-green shale, finely micaceous, not calcareous.

This seems to belong to *C. stygia.* It shows two segments and appendages, pressed sideways. Style, 50 mm.; one stylet present, broad and ensiform, 23 mm. long. The lattice-pattern ornaments the segments and head of the telson, which latter is much crushed.

M. P. G. x $\frac{1}{25}a$, $\frac{1}{25}b$, $\frac{1}{25}d$, Logan Water, Lesmahago. Segments with oblique striæ (one ultimate segment has straight striæ), not well preserved. Probably *C. stygia*, as named in the 'Catal.,' 1878, p. 142.

Pl. X, fig. 7 (Cambridge Mus. *b*/35). An internal cast of a convex valve, retaining a very thin film of the test. The antero-dorsal angle has been damaged. This valve, in "Ludlow" rock (grey, micaceous, partly calcareous sandstone) from Benson Knot, Kendal, belongs probably to *C. stygia*,[1] or a variety of that species, if it be not a male individual, having (like Pl. XII, fig. 2) less ventral depth than usual among the many specimens from Lesmahago. The surface has parallel, longitudinal striæ; very delicate in the dorsal region, coarser below the middle, where they curve with the ventral margin, and here and there some die away.

Cambridge Mus. *b*/6 is a large hollow cast of a similar valve, imperfect. Upper layer of the stone with the cast not calcareous; lower part calcareous.

Pl. XI, fig. 1 (Cambr. Mus. *b*/36) is a caudal extremity, found also at Benson Knot, which would apparently suit such valves as Pl. X, fig. 7, and is not distinct from *C. stygia*, except that the telson has a *bulbous* or *rounded head*. As this is probably a specific character, we must not refer the associated valves (Pl. X, fig. 7) to *C. stygia* without some doubt. It is possible, however, that the latter species may have had such a telson-head, but that pressure and decomposition have generally destroyed all trace of it in the fossils.

A fine large specimen of this narrow variety of *C. stygia* (?), with a round-headed telson, is in the Museum of the Geological Survey of Scotland (M. 447), Edinburgh, from Eaglinside Burn, River Nethan, 4½ miles south-west of Lesmahago.

The specimen A, Oxford Museum (Grindrod Collection), Pl. XI, fig. 7, consists of the penultimate (11 mm.), and ultimate (20 mm.) segments, both finely lattice-marked, together with a broad style (45) and corresponding stylet (22 mm.), of what seems to be too large for *C. robusta,* but not long enough for *C. longa.* These caudal spines are strong, broad, and ensiform, the style is fluted; the stylet flat, except its marginal rims. The two segments are neatly ornamented with

[1] 'Fourth Report Foss. Phyll.,' 1886, p. 232, and 'Geol. Mag.,' 1886, p. 459.

imbricate lozenge-shaped, or sharp leaf-like lines, each angle inclosing a smaller leaf-like lattice-work, as in Barrande's *C. Scharyi:* all are pressed sideways. This is in the Lower-Ludlow mud-stone, olive-grey, laminated, and micaceous, associated with the remains of an Orthoceras. It may possibly belong to either *C. papilio* or *C. stygia*, if not to *C. longa;* but the telson appears to have been longer than that of *C. papilio*, and *round-headed.* This feature, which we observe also in a few Scotch specimens, and in Pl. XI, fig. 1, may be a specific distinction.

In the above-mentioned specimen (Cambridge Mus., *b*/36, Pl. XI, fig. 1) of two abdominal segments, with a style and a stylet in good preservation, convex and not injured by pressure, the penultimate segment is smooth, but shows some traces of oblique lines; the ultimate is quite smooth and cylindrical; the telson (style) is attached by an apparently rounded articulation; and the stylet much resembles some of those formerly referred to *C. robusta.* The telson tapers slowly, is smooth, convex along the middle, was about 36 mm. long originally, and is bordered by a slightly-raised rim. The stylet, like a broad sharp blade, about 20 mm. long, also has its edges rimmed. The joint for the telson-head is not well-exposed, but seems to be round and hollow. The place of attachment for the left stylet is not distinguishable, owing perhaps to a lateral shift in the position of these appendages. This specimen, preserved in dark-grey sandstone, micaceous and slightly calcareous, with part of an internal cast of an Orthoceras, is from Benson Knot, and is labelled "C. inornatus;" but the evidence of this specific relationship is supported only by its having been found in the same rock, and by its size suiting the large form referred to "C. inornatus" (but probably *C. stygia*) in the Cambridge Museum (*b*/35, Pl. XI, fig. 1). This specimen is very much like the caudal appendage of *C. stygia*, but it has a *round-headed telson.*

Pl. XII, figs. 2 *a*, 2 *b*. Brit. Mus., No 45154. In the black shale of Lesmahago. Slimon Collection. Right valve outwards, broken in front; the other partially visible. Delicately striate. Seven body-segments traceable, four exposed beyond the valve; obscure lattice-ornament on the third and fourth from the carapace. Style and stylets nearly perfect, but modified by little roundish pits due to decomposition.

12. CERATIOCARIS LONGA, sp. nov. Pl. VI, fig. 3 (?); Pl. XI, figs. 2, 5.

1878. CERATIOCARIS ROBUSTUS, *H. N. & E.* Catal. C. S. Foss., p. 142.
1885. — ROBUSTA, var. LONGA, *T. R. J. & H. W.* Third Report on Fossil Phyllop., Brit. Assoc. for 1885, p. 350.

The specimens Ludlow Museum S., and M. P. G., x $\frac{1}{17}$, $_2$, have each a long style and a strong stylet, attached to a broken ultimate segment (Pl. XI, figs. 2 and 5), and were regarded as var. *longa* in the 'Third Report,' p. 350. If any ornament was ever present it may have flaked off. The style or telson in these specimens is too long for either *C. stygia* or *C. papilio*; and C. LONGA may stand for a specific name.

Specimen Ludlow Museum S. (Pl. XI, fig. 2) is a broad and long telson (at least 63 mm. long), with linear ornament, from the Lower-Ludlow beds at Bow Bridge, Ludlow. Part of an ensiform stylet, with its slightly convex outer margin, shows from beneath it.

Pl. XI, fig. 2, shows a style, ridged and furrowed, and one broad stylet, both flattened out by vertical pressure, with the dorsal face downwards, and represented by an impression, with some ferruginous replacement, and some remnant of test. The latter is on the lower half of the style, and is partly the inside of the embedded test (dorsal face), and partly the whole substance. There are traces of bristle-bases, here and there towards one side (the left-hand side as figured). The specimen lies in greenish-grey, hard sandstone, slightly micaceous.

Pl. XI, fig. 5. Mus. Pract. Geol. x $\frac{1}{17}$, $_2$ ('Catal. C. S. Foss.,' 1878, p. 142, *C. robustus*). In hard, olive-green, micaceous shale, from Leintwardine, and closely resembling fig. 2 in its telson (56 mm.) and stylet (25 mm.). In both cases the style has been flattened by pressure; in fig. 5 one half longitudinally has split away, and the other has been made rugose by decomposition.

The specimen figured in the 'Silurian System' and 'Siluria,' and copied in Pl. VI, fig. 3, may very well have belonged to such an individual as the specimen marked S in the Ludlow Museum, and described above. In the 'Silurian System,' 1839, it was termed *Onchus*, pl. 4, fig. 63; *Leptocheles* sp. 'Siluria,' 1854 and 1869, pl. 19, fig. 3.

13. CERATIOCARIS ROBUSTA, *Salter*, 1860. Pl. X, fig. 10; Pl. XI, figs 8, 9, 12—15.

1851. PTERYGOTUS LEPTODACTYLUS, *M'Coy* (in part). Brit. Palæoz. Foss., fasc. i, p. 175, pl. 1 E, figs. 7 *c*, 7 *d*.
1860. CERATIOCARIS ROBUSTUS, *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 158.
1865. — — *H. & E.* Catal. Foss. M. P. G., p. 79.
1867. — — *Salter*. In Siluria, 3rd (4th) edit., p. 516.
1873. — — — Catal. Camb. and Sil. Foss., p. 164.
1877. — — *H. Woodward*. Catal. Brit. Foss. Crust., p. 71.
1878. — — (part) *H. N. & E.* Catal. Camb. and Sil. Foss. M. P. G., pp. 84 and 142.
1885. — ROBUSTA, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 349; Geol. Mag., 1885, p. 464.
1886. — — — Fourth Report, p. 231; Geol. Mag., 1886, p. 457.

This species was founded on the caudal appendages of a species the carapace of which has not yet been collated. Hence the species is unsatisfactory to deal with. The original specimens figured by M'Coy, and referred by Salter to a new species, are in the Cambridge University Museum (*a*/925, M'Coy's fig. 7 *c*; *a*/926, fig. 7 *d*). The telson, 32 mm. long (longer than the original figure), is straight, broadly ensiform, 6 mm. wide at its base. The stylets, 20 mm. long, are also relatively broad and ensiform or like a sharp blade. They all seem to have once been faintly fluted and ridged, or costulated. They were obtained from Leintwardine, where they occur in the Lower Ludlow Beds.

Two similar specimens, collected by the late Mr. Lightbody in Upper-Ludlow Beds, "above Ashley Moor," are in the Owens College Museum, Manchester. One of the sets, however, has the stylets nearly as long as the style; whether this was due to variation of growth or to accident, we cannot now decide. The locality is near Richard's Castle, not far from Ludlow.

Oxford Mus. S is a short trifid appendage (not figured), with a style 23 mm. and stylets 13 mm. long; the latter smooth and with a slightly raised rim at the margin; the former faintly fluted and pitted.

Pl. VI, fig. 3. Copied from 'Siluria,' and formerly referred to *C. robusta*, seems to be too large and too much curved for a stylet of the usual form of that species; but it may have belonged to *C. longa* (see page 43).

Pl. X, fig. 10. Mus. Pract. Geol. $\frac{23}{24}$ ('Catal.,' 1878, p. 118). In olive-green shale; slightly micaceous, not calcareous. Lower Ludlow; Leintwardine.

A telson and two stylets, spread out. Dorsal aspect. Telson ridged. Some bristle-bases visible along two rows, one on each side of the main ridge at the broad upper part of the telson (not shown in the figure). Stylets flat, smooth, with the usual rim and slight median ridge.

Pl. XI, fig. 8. Cambridge Mus. *a*/925. "Described by Salter, 'Ann. Mag. Nat. Hist.,' ser. 3, vol. v, p. 158; figured by M'Coy, 'Brit. Pal. Foss.,' pl. i, E, fig. 7 *c* (with 7*d*), as *Pterygotus leptodactylus* erroneously."

This is a telson, with its head retaining some test, flattened and cracked, lying sideways, and bearing some oblique marks, which are possibly remnants of a lattice ornament. The lower part decomposed and rough, but evidently once ridged. One stylet seen, flat and smooth, with delicate lateral rims, its test decomposed.

The fossil occurs in brownish-grey shale; finely micaceous, slightly calcareous on the edge. From the Lower Ludlow Beds of Leintwardine.

Pl. XI, fig. 9. Cambridge Mus. *a*/926. Figured in the 'Brit. Pal. Foss.,' pl. i, E, fig. 7*d*. (See above, fig. 8.) In greenish-grey finely micaceous shale, calcareous on its edge. Leintwardine. A smooth, flat stylet, with slight lateral rims (as in fig. 8). Outer edge rather convex. The upper end obliquely truncate, probably natural, possibly by accident. The test is decomposed and mostly broken away.

Pl. XI, fig. 12. Brit. Mus. No. 58878. In thin, brown, hard shale; finely micaceous. "Linburn, Muirkirk; N.B.—C. W. P."

Telson and two stylets outspread, showing their dorsal aspect. The telson-head is flattened and cracked; the lower part of the telson is somewhat convex, but much corroded; probably once ridged. Its extremity is shown by its impression to have been very thin and sharp, and strongly, but delicately ridged. These caudal spines are shorter than is usual with *C. robusta.*

Pl. XI, fig. 13 *a* and *b*. Brit. Mus. No. 59620 (and its counterpart).

In soft, light brown shale. Buckholm Beds, Gala Group; Meigle Hills, Galashiels. With *Aptychopsis.*

The telson and stylet are represented by a delicate impression, partly tinted with iron-oxide. A small portion of the ultimate segment is represented by a delicate smooth impression (not shown in the figure) above the telson, and of the same width. The joint of telson to the ultimate segment, and of the stylet to the telson are traceable. The telson is neatly ridged and shows two rows of puncta for bristles (fig. 13 *b*); one row as shown in the figure, and another, less easily seen, along the outer furrow. The stylet has a faint trace of having been slightly ridged.

Pl. XI, fig. 14. British Museum, No. 39405. "Lower Ludlow; Leintwardine. Mr. Marston."

Dorsal aspect of a telson, and a separate stylet lying obliquely across and beneath its lower half. Telson-head smooth, retaining some of its test, much corroded, but showing a little of the lattice-pattern very definitely ; five or six ridges go off downwards on this face, and the impression of the lowest moiety of the telson shows that the other (under) face was also ridged. A definite row of bristle-bases (pimples in depressions) is visible along one ridge on the dorsal face, and doubtless there was a corresponding row now obscured.

The loose stylet is smooth, but corroded; and has the lateral rims, the slightly convex outer edge, and obliquely truncated joint end that are seen in figs. 8, 9, and others ; also observable in *C. papilio, stygia*, and *longa.*

Pl. XI, fig. 15. Brit. Mus. 39404. Hard, olive-grey shale,calcareous on the edge. "L. Ludlow ; Leintwardine. Mr. A. Marston."

The under view of style and two stylets, somewhat like fig. 12, but longer and thinner; and towards the end this under side of the telson is marked with a central furrow, which may indicate that the back or outside was angular, and the section like that of a bayonet. Stylets smooth and showing the usual rims and a very slight, central, longitudinal ridge.

14. Ceratiocaris patula, sp. nov. Pl. XI, fig. 11.

1885.	Ceratiocaris robusta (part), *T. R. J. & H. W.*		Third Report Pal. Phyll., p. 350.
1886.	— lata,[1]	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

We find several very small trifid sets of tail-spines, or parts thereof, which at first were thought to belong to small individuals of *C. robusta ;* but a few seem to be quite distinct. For some of the larger of these caudal appendages, which we at first (1885) referred to *C. robusta*, we find equivalent styles, and broad blade-like stylets,like long scalene triangles, in *C. papilio*, *stygia*, *acuminata*, &c. ; but none seem small enough for the several little sets of trifid appendages, more or less perfect, which we have met with. *C. robusta* takes in some small forms (see above) ; but Oxford Mus. T is relatively broad, and might be termed *patula* (Pl. XI, fig. 11) ; Brit. Mus. 58878 from Muirkirk, has very narrow members (*angusta*, Pl. X, fig. 9) ; and one set in the Owens College collection is so neat, symmetrical, and small that it might be called *minuta* (Pl. X, fig. 11).

[1] As this term has been used by Mr. Salter for a species of *Ceratiocaris* (though doubtful), we think it advisable to change it for a synonym (patula).

Oxford Mus. T (Pl. XI, fig. 11) is a little trifid set, near *C. robusta*, and has a style 28 mm. long, and two stylets each 15 mm.; but these appendages are much broader proportionally than those of *C. robusta;* and hence we regard this as a new species, C. PATULA. The stylets are smooth with slight marginal rims; and the style is faintly fluted and pitted (having been spinose) definitely along two rows, one near each margin. It is in Upper-Silurian shale, probably from near Ludlow: as is also Oxford Mus. M, which is much like *C. patula*, but is not figured.

15. CERATIOCARIS ANGUSTA, *T. R. J.* and *H. W.*, 1886. Pl. X, fig. 9.

1885.	CERATIOCARIS, sp. nov. ?, *T. R. J. & H. W.*	Third Report Pal. Phyll., p. 350; Geol. Mag., 1885, p. 465.
1886.	— ANGUSTA, —	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

In the British Museum one of those marked 58878 from Linburn, near Muirkirk, shows a style (21 mm.), tapering, with circular section at base, and apparently smooth, together with a corresponding attached stylet, 16 mm. long. This set differs from the appendages of either *C. papilio* or *C. stygia*, as well as from *C. patula* and *C. minuta*.

16. CERATIOCARIS MINUTA, *T. R. J.* and *H. W.*, 1886. Pl. X, fig. 11; Pl. XI, fig. 10 (?).

1885.	CERATIOCARIS, sp. nov. ?, *T. R. J. & H. W.*	Third Report Pal. Phyll., p. 350; Geol. Mag., 1885, p. 464.
1886.	— MINUTA, —	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

In Owens College Museum, Manchester, is a very delicate little set of caudal appendages (Pl. X, fig. 11). The style (central) shows a circular section at its base (top), about 2 mm. wide, is 12 mm. long, and tapers gently to a sharp point. The lateral stylets are 8 mm. each. All are subcylindrical, and delicately ridged and fluted. From the Lower-Ludlow or Aymestry Limestone, on the old road at Mocktree; collected by the late Mr. Lightbody.

Mus. Pract. Geol. D $\frac{22}{14}$ ('Catal. C. S. Foss.,' 1878, p. 118), from the Lower

Ludlow beds at Leintwardine, is a somewhat similar little set of appendages (three spines), but broken off at the top. What remains of the longest middle one, is 8 mm., of the two lateral stylets 6 mm. (Pl. XI, fig. 10.)

These may represent a very young condition of some of the foregoing species; but they probably belong to a distinct species.

17. Ceratiocaris inornata, *M'Coy*, 1851. Pl. X, figs. 2, 3, 5.

1851.	Ceratiocaris	inornatus	(Salter MS.), *M'Coy*.	Brit. Pal. Foss., p. 137, pl. 1 E, fig. 4.
1854.	—	—	*Morris*.	Catal. Brit. Foss., 2nd edit., p. 102.
1859.	—	—	*Salter*.	In Siluria, 2nd (3rd), edit., p. 532.
1860.	—	—	—	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 156.
1865.	—	—	*H. & E.*	Catal. Foss. M. P. G., p. 79.
1867.	—	—	*Salter*.	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	—	—	Catal. Camb. Sil. Foss., pp. 177, 178.
1877.	—	—	*H. Woodward*.	Catal. Brit. Foss. Crust., p. 71.
1885.	—	inornata,	*T. R. J. & H. W.*	Third Report Pal. Phyll., pp. 345, 346; Geol. Mag., 1885, p. 460.
1886.	—	—	—	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

This is the third of M'Coy's original species of the genus *Ceratiocaris*. The specimen (Pl. X, fig. 3) *b*/5, in the Cambridge Museum, from Benson Knot, has its carapace ovate-oblong or somewhat boat-shaped in outline, 50 mm. (2 inches) long, height 18 mm.; moderately convex; straight above and arched below (both edges are partly embedded in the matrix of the original specimen, *b*/5, M'Coy's fig. 4). The anterior end (damaged) was neatly rounded, sloping up gracefully from below; the posterior is obliquely truncate from above downwards and outwards, with a slight ogee curve at the top; the postero-dorsal angle distinct, and the postero-ventral angle prominent but blunt. There is no eye-spot. Traces of delicate, parallel, longitudinal striæ are visible on the impressions of the valves in the grey stone, strongest on the middle and ventral regions. Two specimens (one of them good, Pl. X, fig. 2) are in the British Museum, No. 44342, from the same locality. Sometimes the valves have been wrinkled longitudinally and irregularly by pressure, showing that they were thin and toughish (Pl. X, figs. 3 and 5).

The foregoing description does not quite tally with the account of the species

given in the 'Brit. Pal. Foss.,' p. 137, nor with that in the 'Ann. Mag. Nat. Hist.,' l. c., but is based on the original specimens, and not on the *restored* figure in the 'Brit. Pal. Foss.' The diagrammatic figure annexed by Mr. Salter to his note on *C. inornata* in the 'Catal. Camb. Sil. Foss. Mus. Univ. Cambr.,' 1873, p. 178, is used also in connection with two other species at p. 16 and p. 164; and is much like the form which we recognise as *C. Halliana.*

C. inornata approaches *C. papilio* in form, but is smaller and otherwise distinct. There is one from Lesmahago, Lanarkshire, in dark coloured shale, calcareous on its edges, B. M. 59648 (Pl. X, fig. 5), near to *C. papilio* in form, but measuring 34 × 13 mm., and one from Benson Knot, Kendal, Westmoreland, in hard grey sandstone, micaceous, and slightly calcareous, B. M. 44342 (Pl. X, fig. 2), measuring 35 × 14 mm. These proportions are different from those of *C. papilio.* These two are rather smaller than M'Coy's original *C. inornata*, which is about 50 × 20 mm., but have the same proportions, the normal length being 2½ the height; whilst *C. papilio* is larger and has less height in proportion, the length being only twice the height, or even less.

Pl. X, fig. 3. Cambridge Museum *b*/5. "Upper Ludlow;" Benson Knot, Kendal. This was figured by M'Coy, 'Brit. Pal. Foss.,' pl. 1 E, fig. 4, and mentioned by Salter, 'Catal. Cambr. Foss.,' p. 177. It is in hard, dark-grey, micaceous sandstone, slightly calcareous on the edge. There is no eye-spot, the marks being adventitious.

18. Ceratiocaris Ruthveniana, *T. R. J. & H. W.*, 1886. Pl. X, fig. 6.

1885.	Ceratiocaris inornata,		*T. R. J. & H. W.*	Third Report Pal. Phyll., p. 345; Geol. Mag., 1885, p. 460.
1886.	—	Ruthveniana,	—	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

From among the specimens formerly called *C. inornata* we have removed one of the specimens found at Benson Knot, and marked 44342 in the British Museum (Pl. X, fig. 6), being decidedly different in outline (more ovate), though somewhat similarly marked with longitudinal striæ. It might well be named C. Ruthveniana, in memory of the old geological collector who laboured for very many years in the Kendal district for Professor Sedgwick and others.

The carapace is nearly of the shape of half an egg cut lengthwise; almost straight above, elliptical below, and boldly rounded behind; probably rounded with a blunt point, nearly on the dorsal line, in front. Longitudinally striate.

This is near *C. inornata*, M'Coy, but far more convex on the postero-ventral border, and more fully rounded behind; thus differing in its proportion and shape.

It lies in the usual dark-grey sandstone, micaceous, slightly calcareous on the edges, and containing remains of bivalve shells. Longitudinal striæ are visible in certain lights on the thin brownish film left by the test. The valve is broken and imperfect. It has a strong rim on the ventral margin. The central spot is due to an accidental blow.

19. Ceratiocaris Oretonensis, *H. Woodward*, 1871. Pl. X, fig. 4.

1871.	Ceratiocaris Oretonensis,		*H. Woodward.*	Geol. Mag., vol. viii, p. 105, pl. 3, fig. 1.
1878.	—	—	—	Catal. Brit. Foss. Crust., p. 71.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., pp. 346; Geol. Mag., 1885, p. 461.
1886.	—	—	—	Fourth Report, p. 232; Geol. Mag., 1885, p. 459.

This Carboniferous species, described in the 'Geological Magazine' for March, 1871, approaches closely to some of the forms of *Ceratiocaris* found in the Upper Silurian of Benson Knot. The carapace (50 × 24 mm.) is larger than *C. inornata*, M'Coy; but does not attain the size and proportions of *C. papilio*. In re-examining the specimens we find that the anterior end is not so much rounded as in fig. 1 of pl. 3, 'Geol. Mag.,' 1871, but is slightly and obliquely truncate; and the antero-ventral margin is more sloping and less convex; thus the greatest depth of the carapace is in the hinder half. The possible "eye-spot" mentioned at p. 105, *op. cit.*, is too indistinct to be at all recognisable as such. There are four specimens in the British Museum from the Yellow Carboniferous Limestone of Oreton and Farlow, Worcestershire, not well preserved.

Carapace boat-shaped, convex, straight on the back, elliptical below, with the postero-ventral margin more boldly curved than in Pl. X, fig. 7 *a*, and even than in figs. 2, 3, and 5. The mid-ventral border is not nearly so deep in proportion as in fig. 7 *a*. The antero-ventral border is more convex than in the others here referred to. The hinder margin of the best specimen (here figured), is imperfect, but appears to have suddenly sloped off (at an angle of about 35°) from the dorsal edge to a well-curved end. An antero-dorsal angle was probably present but is now wanting.

C. Oretonensis differs from the associated *C. truncata* in being larger, and fuller in the antero-ventral region. Its postero-dorsal slope has a different angle from that of *C. truncata*, fig. 1.

Pl. X, fig. 4. Brit. Museum No. 58884, from Oreton, Worcestershire (Baugh Collection), is in a drab-coloured, coarse-grained, and partly oolitic limestone; a thin layer of shell remains, but it has been much dissolved.

20. CERATIOCARIS TRUNCATA, *H. Woodward*, 1871. Pl. X, figs. 1 *a* and 1 *b*.

1871.	CERATIOCARIS	TRUNCATUS,	*H. Woodward.*	Geol. Mag., vol. viii, p. 106, pl. 3, fig. 2.
1878.	—	—	—	Catal. Brit. Foss. Crust., p. 72.
1885.	—	TRUNCATA,	*T. R. J. & H. W.*	Third Report Pal. Phyll., p. 346; Geol. Mag., 1885, p. 461.
1886.	—	—	—	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

The smaller species occurring with *C. Oretonensis* was described and figured with it in 1871. There are eight specimens in the British Museum, but few of them are at all well preserved. The best carapace measures 35 × 16 mm. The slightly concave truncation of the hinder end is not well rendered in the 'Geol. Mag.,' 1871, pl. iii, fig. 2. Its smaller size, its sharp antero-dorsal angle, and more elliptical ventral curve, distinguish *C. truncata* from its associate, but scarcely separate it, as far as outline is concerned, from some specimens of *C. inornata* at Benson Knot.

Carapace boat-shaped, straight above, elliptical below, curving up less quickly before than behind, where there is a fuller curve going up to meet a truncate edge which slopes at about 50°, with a very slight ogee curve. An indentation and a sharp point mark the front angle.

This is much like Pl. X, fig. 2 (*C. inornata*), but it has a fuller postero-ventral region, and is not so full in the antero-ventral region. The peculiar antero-dorsal angle is not present in *C. inornata*.

Pl. X, figs. 1 *a* and 1 *b*. Brit. Mus. No. 58885, from Oreton, is a left valve in Yellow Carboniferous Limestone. 1 *a* (convex cast) retains a thin whitish film of the test over the greatest convexity; 1 *b* (hollow impression) has some of the shelly film still remaining at its ends.

21. CERATIOCARIS SOLENOIDES, *M'Coy*, 1849. Pl. VIII, figs. 4 *a*, 4 *b*, 5, 7 *a*, 7 *b*, 8 *a*, 8 *b*, 9 *a*, 9 *b*, 10 *a*, 10 *b*.

1849. CERATIOCARIS SOLENOIDES, *M'Coy*. Ann. Mag. Nat. Hist., ser. 2, vol. iv, p. 413, with woodcut.
1851. — — — Brit. Palæoz. Foss., fasc. i, p. 138, pl. 1 E, figs. 5, 5 *a*.
1854. — — *Morris*. Catal. Brit. Foss., 2nd edit., p. 173.
1860. CULTELLUS? (CERATIOSOLEN?) RECTUS, *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 160.
1865. CERATIOCARIS SOLENOIDES, *Huxley & Etheridge*. Catal. Foss. M. P. G., p. 79.
1873. — — *Salter*. Catal. Camb. and Sil. Foss., p. 178.
1877. — — *H. Woodward*. Catal. Brit. Foss. Crust., p. 71.
1878. — — *H. N. & E.* Catal. Foss. M. P. G., p. 142.
1885. — — *T. R. J. & H. W.* Third Report Pal. Phyll., p. 347; Geol. Mag., 1885, p. 461.
1886. — — — Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

Prof. M'Coy founded the genus on this species and *Emmelezoe elliptica* in 1849; but the original specimens in the Cambridge Museum (*b*/40, *b*/41) are not drawn with sufficient exactness in M'Coy's figs. 5 and 5 *a*. The carapace is elongate, subcylindrical, slightly convex on the sides, with an even elliptical anterior curve, and an oblique, slightly curved truncation posteriorly. There are faint traces of longitudinal striæ on the hollow impressions of the valves in the matrix, and there is a slight impression of the ventral rim. The large valve is 43 mm. long (M'Coy's fig. 5); the smaller specimen (fig. 5 *a*) 27 mm., is apparently broken behind, but does not show the double valve there as given in the figure. We cannot distinguish any "nuchal furrow," nor is there any "eye-spot;" a mark consisting of two minute adventitious pits in the anterior third of one of the specimens, and a little hole in another, have been mistaken for it. Mr. Salter in 1860 thought that these little fossils were Molluscan;[1] but they certainly may well claim to be Phyllopods, as he afterwards recognised them to be. There are other specimens in the Cambridge Museum. In the British Museum there are four rather large, but not well-preserved, specimens (44342). All the above come from the Upper-Ludlow grey micaceous sandstone of Benson Knot, near Kendal, Westmoreland.

[1] See 'Ann. Mag. Nat. Hist., l. c., p. 159, *note;* and Sedgwick's 'Lists of Kendal Fossils,' Wordsworth's Letters on the Lakes,' 1843—46, Appendix.

The carapace is elongate, boat-shaped, straight above, curved below, rounded to a blunt point (on the medial line) in front; truncated obliquely from above downwards and backwards behind, making with the postero-ventral upward curve a blunt point below the medial line.

Pl. VIII, figs. 4 *a*, 4 *b*. Cambridge Museum *b*/40, marked "*Ceratiocaris solenoides*, M'Coy." In dark-grey, micaceous, fine-grained sandstone, slightly calcareous; from Benson Knot, Kendal, Westmoreland. This is an imperfect carapace, embedded whilst open to some extent, and therefore extra wide in its dorsal aspect. Prof. M'Coy's fig. 5 *a* is a sketch of this specimen free of matrix; but the broken end is not correctly given; there is no eye-spot at all, and the figure is reversed.

Pl. VIII, fig. 5. Cambridge Museum, with *b*/8. Benson Knot. In the same sandstone as *b*/40. The back and the left-hand (posterior) end in the figure are obscured by matrix.

Pl. VIII, figs. 7 *a*, 7 *b*. Cambridge Museum *b*/41, marked "*Ceratiocaris solenoides*, M'Coy." Benson Knot. In the same sandstone.

This seems to be M'Coy's fig. 5; if so, the sketch is reversed, and there is no eye-spot (only a little accidental hole near the anterior end). It has traces of longitudinal striæ, and of the ventral rim.

Pl. VIII, figs. 8 *a*, 8 *b*. Cambridge Museum *b*/8. Benson Knot. In the same sandstone. The left-hand end in the figure is obscured by matrix (anterior).

Another, marked 'R. I. M., Benson Knot,' is the internal cast of a right valve, partly buried at each end. There is some obscure lineation; fine longitudinal striæ being visible (under the lens) on the anterior half.

Pl. VIII, figs. 9 *a*, 9 *b*. Mus. Pract. Geol. x $\frac{1}{18}$ (Cat., 1878, p. 142). In Upper-Ludlow dark-grey, micaceous, fine-grained sandstone; from Benson Knot, Kendal. A convex cast; smooth; with the ends partially obscured, especially that at the left-hand of the figure.

Pl. VIII, figs. 10 *a*, 10 *b*. Cambridge Museum, with *b*/41. In dark-grey, micaceous, fine-grained sandstone, slightly calcareous; from Benson Knot. It has very faint traces of longitudinal striæ, and a slight trace of the ventral rim. There are two small adventitious pits on the anterior third of the valve, but no ocular spot.

22. Ceratiocaris gobiiformis, *T. R. J. & H. W.*, 1885. Pl. VIII, figs. 6 *a*, 6 *b*, 11 *a*, 11 *b*.

1885. Ceratiocaris gobiiformis, *T. R. J. & H. W.* Third Report Pal. Phyll., Brit. Assoc., p. 347; Geol. Mag., 1885, p. 462.
1886. — — — Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

A form closely approaching *C. solenoides* in shape, but smaller, less acute in front, usually more vertically truncate behind, and much more convex on the ventral border, accompanies *C. solenoides* in the Upper-Ludlow sandstone of Benson Knot. One of the specimens marked *b*/8, Cambridge Mus., is 27 mm. long by 9 mm. high; one in the Brit. Mus., No. 44342, is 30×10 mm. The valves seem to have been smooth. They are somewhat boat-shaped in outline, and distantly resemble a deep-bodied, blunt-headed little fish, such as a gudgeon, without its tail; convex; straight or nearly so in the back, strongly curved below; rounded to a very blunt angle in front, obliquely truncate behind. It is possible that this may be a varietal or sexual form of *C. solenoides*, but it seems to be sufficiently well separated from its ally to require a distinctive name, so we refer to it as C. gobiiformis.

This is near *C. solenoides*, but is relatively broader (higher) and shorter; the ventral margin is much more convex, and the front end blunter.

Pl. VIII, figs. 6 *a*, 6 *b*. Brit. Mus., one of the specimens marked No. 44342. In dark-grey, micaceous, fine-grained sandstone, slightly calcareous; from Benson Knot.

Pl. VIII, figs. 11 *a*, 11 *b*, 11 *c*. Cambridge Museum *f* 142. In dark-grey sandstone, calcareous; from Benson Knot. In this small valve (10×4 mm.), the ventral border is still somewhat embedded in the matrix; and there are three small adventitious accretions on the apparently smooth surface.

23. Ceratiocaris Salteriana, *T. R. J. & H. W.*, 1885. Pl. VII, figs. 1 *a*, 1 *b*, 2, 3.

1885. Ceratiocaris Salteriana, *T. R. J. & H. W.* Third Report Pal. Phyll. Brit. Assoc., p. 348; Geol. Mag., 1885, p. 462.
1886 — — — Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

Four specimens, in rather different states of preservation, from the Lower-Ludlow strata, indicate the existence of a distinct species of *Ceratiocaris*, having nearly oblong carapace-valves, with almost equally rounded ends, and ornamented with delicate but distinct horizontal parallel lines, rather wide apart.

One of these, a carapace, M. P. G. D $\frac{22}{14}$ *a*, 1 & 2, from Bow Bridge, Ludlow, well preserved, is 30×15 mm., straight on the back, rounded at the ends. The two counterparts are here figured, figs. 1 *a*, 1 *b*.

In very fine-grained, grey, micaceous, and partly calcareous mudstone, breaking unevenly, are the two light-brown, suboblong valves, one shifted on the other, and more or less buried in the matrix at the dorsal edge; smooth, with delicate, parallel, longitudinal striæ, a centimètre apart where broadest, running closer to each (some dying out) near the ventral margin. Marginal rim strong and narrow.

The transverse markings are of mechanical origin, being due to small narrow patches of the test remaining alongside of numerous obliquely-transverse cracks.

In fig. 1 *a*, D $\frac{22}{14}$ *a* 2, the right valve is uppermost, but is only partly seen, its dorsal edge and both of its angles being lost in the matrix. [The antero-ventral curve is rather too bold in the drawing.] The raised striæ are seen on the upper left-hand portion (posterior third of the right valve), one centimètre apart, and ending abruptly in the posterior rim.

The lower part of the specimen is the inside of the left valve, with sunken striæ on the inner face of the test.

Fig. 1 *b*, D $\frac{22}{14}$ *a* 1, is the counterpart of two-thirds of the compressed carapace.

In the Cambridge Museum, *a*/694 (Fletcher Collection), marked "Dudley; in upper shale," which is a dark-grey, very fine-grained, and slightly calcareous mudstone, of the Lower Ludlow formation, is a similar carapace (Pl. VII, fig. 2), nearly as well preserved as fig. 1, and measuring 30×13 mm. It is mentioned by Salter in the 'Catal. Camb. and Sil. Fossils Mus. Cambridge,' 1873, p. 129.

The ventral margin has a distinct raised rim. The striæ and interspaces differ in tint of colour on the cast. Some internal organs (teeth?) have caused a little break or hole, and a derangement of the striæ in the antero-dorsal region. The valve is suboblong. The hinder margin has a slight ogee curve; the front is

broken, but probably ended originally in a neat angle at or near the dorsal margin. The parallel striæ are slightly raised on the remaining patches of the thin, smooth, brown test. Striæ sometimes one centimètre apart, but closer together towards the ventral edge. Marginal rim strong.

Another specimen (Pl. VII, fig. 3), also from the Lower Ludlow series, evidently belongs to the same species. It is the specimen M in the Oxford Museum (Grindrod Collection), and it is preserved in greenish-grey, micaceous, and calcareous mudstone. This suboblong carapace is broken at the ends, with the right valve embedded. An imperfect thin film of the other, retaining a small patch of fine longitudinal striæ near the ventral margin in the hinder half, covers the obscure subconvex mass representing the contents of the carapace. The anterior fracture shows this little mass to contain some minute indefinite remains of organic parts, like two vertical rows of roundish spots (? sections of limbs).

The posterior fracture exhibits four of the body-segments, preserving their smooth test, within the carapace and continuous with others still further in. Outside the carapace are the penultimate and ultimate segments. The last segment (6 mm. long) is marked with faint striæ, slightly oblique from above downwards and backwards. A style (about 12 mm.) and one stylet (7 mm.), both smooth and rather broad or dagger-shaped, are attached by an indistinct articulation.

We wish to associate this rare but distinct species of *Ceratiocaris* with the name of our deceased friend Mr. J. W. Salter, who worked so long and so well on these and allied *Phyllopoda.*

24. Ceratiocaris laxa, *T. R. J. & H. W.*, 1886. Pl. VIII, fig. 12; Pl. X, fig. 12.

1885. Ceratiocaris stygia, *T. R. J. & H. W.* Third Report Palæoz. Phyll., p. 345; Geol. Mag., 1885, p. 396.

1886. — laxa, — Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

One of the specimens in the British Museum marked 59648, from Lesmahago, is a small acute-ovate carapace (25×13 mm.), pointed in front, truncate behind, with which is associated a complete, but somewhat crushed, body of thirteen or fourteen segments, five (15 mm.) of which are external, and have appended to them a neat trifid set of long, narrow, sharp appendages. The strongest is the telson, delicately ridged, and 17 mm. long; and the others, about 8 mm. long, are the stylets.

This small and very delicate specimen (Pl. VIII, fig. 12), in black shale, with a small, thin, calcareous vein, from Lesmahago, exhibits on the anterior part of its

thin sub-ovate carapace excessively fine, parallel, longitudinal striæ (Pl. X, fig. 12). This form differs from any other we know. Its looseness of structure suggests the name LAXA.

On another of the specimens in the British Museum, marked 59648, from Lesmahago, are three loose small *bodies*, without carapaces (Third Report, p. 345). The largest has thirteen or fourteen segments (45 mm. in length), some of which are obliquely striate. Five measure 25 mm., and the last one 10 mm., equal to three of the others. The telson is 20 mm. long. Another such specimen, smaller and narrower, 35 mm. long, has fourteen (?) segments; the last one 7 mm. long; appendages imperfect.

These may be the loosened and shifted abdomens of either young individuals of *C. stygia* or *C. papilio*, both common at Lesmahago, or more probably of *C. laxa*. They cannot be mistaken for the Carboniferous *Acanthocaris*, Peach, or the Devonian *Campecaris*, Page.

25. CERATIOCARIS COMPTA, *T. R. J. & H. W.*, 1886. Pl. VII, figs. 10 *a*, 10 *b*.

1885.	CERATIOCARIS CASSIA (part), *T. R. J. & H. W.*	Third Report Pal. Phyll., p. 348; Geol. Mag., 1885, p. 463.
1886.	— COMPTA, —	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

The specimen H in the Ludlow Museum, from Trippleton, is a very small, ovate, filmy relic of a valve (13 × 7 mm.), with a loose abdomen of four segments (12 mm.), and a neat little outspread trifid caudal appendage; style about 10 mm. long, stylets 6 mm. These all are flat, smooth, and thickened at their edges.

The carapace was subovate, sharp in front, and obliquely truncate behind. The segments, flattened and split along the middle by vertical pressure, are delicately striate (fig. 10 *b*), with oblique lines (outwards and downwards) on each side, suggesting the name COMPTA, which we propose for this species as being distinct from any known form.

Pl. VII, figs. 10 *a*, 10 *b*, Ludlow Museum H, is from the Lower-Ludlow, greenish-grey, finely micaceous mudstone, not calcareous; and was collected by Mr. Marston at the roadside quarry south-east of Trippleton.

This small valve is represented by a black film, nearly ovate. The abdomen and three caudal appendages have been laid out symmetrically by vertical pressure. The oblique lateral striation on the segments is very plain under a lens (fig. 10 *b*).

26. Ceratiocaris cassia, *Salter*, 1860. Pl. VII, figs. 7 *a*, 7 *b*, 7 *c*, 7 *d*, 7 *e*.

1860.	Ceratiocaris	cassia,	*Salter.*	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 159.
1865.	—	—	*Huxley & Etheridge.*	Catal. Fossils M. P. G., p. 79.
1867.	—	—	*Salter.*	In Siluria, 3rd (4th) edit., p. 516.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 70.
1878.	—	—	*H., N. & E.*	Catal. Camb. Sil. Foss. M. P. G., p. 141.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., p. 348; Geol. Mag., 1885, p. 463.
1886.	—	—	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

C. cassia is recognised on an interesting slab, of which one counterpart is in the Ludlow Museum (E and F) and the other in the Museum of Practical Geology at Jermyn Street, London (x $\frac{1}{1}$). Neither gives the form quite complete; the lower specimen on each slab seems to have been much modified. They are the originals seen and noticed by Mr. Salter.

The carapace is suboblong, horizontally striate; truncate, with an ogee outline behind; pointed in front; postero-dorsal angle above the median line; anterior angle on the median line; 20 mm. long, and 11 mm. high. Of the body-segments one or two are exposed, altogether 6 mm. in length, longitudinally or obliquely striate. Telson and stylets rather short, sharp, delicately ridged; stylet 4 mm., style about 9 mm. long.

Figs. 7 *a*, 7 *b*, Ludlow Museum E and F; figs. 7 *c*, 7 *d*, 7 *e*, M. P. G. x $\frac{1}{1}$. From Lower-Ludlow beds, at a roadside quarry, Trippleton Farm, near Leintwardine. Marked "*Ceratiocaris cassia*, Salter." Both counterparts consist of a greenish-grey, rather hard mudstone, fine-grained, slightly micaceous, and somewhat calcareous, especially along thin whitish seams at the edge.

Two carapaces are represented by two pairs of thin brown valves, much squeezed and crumpled. The upper carapace retains its ogee hinder border, and its pointed front extremity, both much above the medial line, but on the long axis of the valves. Marginal rim strong; the surface is ornamented with delicate, longitudinal, and parallel striæ. The lower carapace is more distorted than the other, blunter in front, and squeezed into a narrower shape.

Besides the wrinklings by pressure, there are irregularities of the surface due to internal organs in the anterior moiety of each carapace. In the larger (upper) carapace there is a minute, flask-shaped, pitted depression just beneath a very small pimple in the anterior region. At first sight these marks have the look of *ocular* tubercles; but after careful examination we are not inclined to give them that importance.

Each individual has the ultimate body-segment in place, with short caudal spines. A very delicate oblique striation is present on the exposed segment of the lower specimen. The telson shows minute pittings in the upper specimen of fig. 7 *a*.

Projecting from the edges of these carapaces are broken pieces of ventral rims of other specimens. These remnants are figured on a larger scale in figs. 7 *d* and 7 *e;* and a piece of a rim (fig. 7 *b*) from fig. 7 *a* is given to show the characteristic arrangement of the striæ running into the marginal rim, and determining the nature of figs. 7 *d* and 7 *e*.

27. CERATIOCARIS CASSIOIDES, *T. R. J.* and *H. W.*, 1886. Pl. III, fig. 9; Pl. IV, fig. 7; Pl. VII, figs. 4, 5, 6.

1878. CERATIOCARIS VESICA (part), *Huxley, Newton, and Etheridge.* Catal. Foss. M. P. G., p. 142.
1885. — SALTERIANA (part), C. CASSIA (part), and CERATIOCARIS, sp. nov. ?, *T. R. J. & H. W.* Third Report, pp. 348, 349; Geol. Mag., 1885, pp. 462, 463.
1886. — CASSIOIDES, *T. R. J. & H. W.* Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

Carapace deeply boat-shaped, very slightly convex on the back at the anterior third, where it slopes down to the front; pointed or beaked in front, boldly curved below, and obliquely truncate, with an upward and outward ogee slope behind. Surface smooth; much wrinkled by pressure, showing its soft but tough consistency. The ultimate segment has faint oblique striæ from above downwards and backwards. The telson in one specimen (Pl. IV, fig. 7) is 11 mm. long. Stylet shorter.

Somewhat similar to *C. cassia*, in the characters of the carapace, but larger and otherwise different. The specimens have more abdominal segments exposed and proportionally longer caudal appendages. The species might be conveniently named C. CASSIOIDES.

These specimens should be studied in the order of Pl. VII, fig. 6, fig. 4, fig. 5; Pl. III, fig. 9; and Pl. IV, fig. 7, for accurate and gradational comparison.

Mus. Pract. Geol. x $\frac{1}{26}$ ('Catal. C. S. Foss.,' 1878, p. 142), has its carapace and abdomen preserved in place. This is marked "*Ceratiocaris vesica*, Salter; Lower Ludlow; Leintwardine;" and is in an olive-grey mudstone, finely micaceous, and

partly calcareous; casts of small Brachiopoda and *Cardiola interrupta* are present on a bed-plane. It differs very much from *Physocaris vesica,* although nearly of the same size. The carapace is subtriangular, 25 mm. long and 14 mm. deep at the middle of the ventral margin (Pl. VII, fig. 6.) The back is straight, but curved down at both ends to meet the steep upward slopes of the lower margin. The abdomen (15 mm. long) comes out, as usual, from the upper part of the hinder region. The carapace is represented by a thin, brownish, wrinkled film; the irregular crumpling in the antero-dorsal region is probably due to the presence of hard remains of internal organs. [The front extremity is not quite so distinct as in the drawing.] Four body-segments and a small part of the caudal appendages remain attached. The ultimate (6 mm.) and penultimate segments retain their test, which is obliquely striated.

Specimen Ludlow Mus. J (from Trippleton, near Leintwardine) has a smaller but nearly similar carapace (22 × 12 mm.), gently convex on the back, deeply curved below, and with almost equal, sharp dorsal angles in front and behind.

Specimen Ludlow Mus. K, from Trippleton, near Leintwardine, has a carapace (23 × 12 mm.), five (?) abdominal segments (10 mm.), and appendages, of which the style (pitted with bases of little spines) is imperfect, but a stylet measures 5 mm. (Pl. VII, fig. 4).

Much narrower than those above mentioned is B. M. 39400 (Pl. III, fig. 9), which has been squeezed, so as to have its outline modified. It is in olive-grey micaceous mudstone, weathering brownish, from the Lower-Ludlow beds at Church Hill, Leintwardine.

The part of carapace preserved is much crumpled, but seems to have been smooth. The converging wrinkles at the hinder end may have been altogether due to pressure. There are some obscure indications of internal organs, including an elongate, slightly curved, fimbriated, branchial (?) appendage, or displaced antenna, lying lengthwise in the ventral region. There are also obscure remains of abdominal segments and appendages, altogether about 17 mm. long. A hollow cast belonging to the same species, B. M. 44342, from Benson Knot, has a better preserved outline. It is nearly oblong, slightly arched above and below, truncate with hollow curve behind, pointed and mucronate in front. In outline this approaches Pl. IV, fig. 7, but is larger and proportionally deeper.

As in *C. cassia* so in *C. cassioides*, the carapace has been apparently thin and tough, so as to allow of it being crumpled very much. This condition and the presence of harder parts of their internal organs beneath give rise to various irregularities of the surface, in some cases simulating ocular tubercles. There are, however, no real eyespots. Some of the superficial derangements may be due to the attachment of the muscles of the jaws within the carapace.

Pl. IV, fig. 7. Oxford Museum Q. Lower Ludlow. In the usual mudstone,

calcareous at the edge. Here we have probably two valves, pressed together and crumpled; a film of *smooth* test is visible; the segments are continued inwardly. An obscure, filmy, lineated, sharply-elliptical body, lying obliquely just above the anterior point of the valve, may be a relic of the *rostrum*. There are three outer segments and a strongly-ridged, sharp telson.

Pl. VII, fig. 4. The specimen, Ludlow Museum K, is in a greenish-grey, non-calcareous, finely micaceous mudstone, Lower Ludlow. From the old roadside quarry south-east of Trippleton. Collected by Mr. A. Marston.

Carapace with almost perfect outline of the embedded left valve, but with only a fragment of the outside of the right valve (posterior third); purplish in tint; marked with parallel striæ wide apart, and with transverse cracks. The marginal rim is strong, as shown by the impression.

There are three abdominal segments exposed, and indications of others. The caudal appendages are rather obscure.

Pl. VII, fig. 5. Oxford Museum L. In Lower-Ludlow yellowish-grey, finely micaceous mudstone, not calcareous.

Carapace represented by a hollow impression of the right, and a postero-dorsal fragment of the left valve. The outline is well preserved, subovate, straight on the postero-dorsal edge, which terminates with an angle above the medial line of the valve, over a slightly ogee curve on the truncate end. The anterior curves meet in an elegant point almost on the medial line. A small mass of obscure organic matter occupies the antero-dorsal region. Indistinct longitudinal striæ are traceable on the remnant of the left valve. The ventral rim of the right valve is indicated by a strong impression on the matrix, with a few delicate striæ near by. Three abdominal segments, with a telson and one stylet, are attached; all apparently smooth, but under the microscope there are traces of a fine lineation on the segments. The appendages, not exposed to their ends, are rugose with pits, due probably to decomposition.

28. Ceratiocaris (?) longicauda (*D. Sharpe*), 1853. Pl. XI, figs. 16 *a*, 16 *b*.

1853. Dithyrocaris? longicauda, *D. Sharpe*. Quart. Journ. Geol. Soc., vol. ix, p. 158, pl. 7, fig. 3.
1885. Ceratiocaris? longicauda, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 354.
1886. — — — Fourth Report, p. 233; Geol. Mag., 1886, p. 460.

The ultimate segment and trifid appendage of a small Ceratiocarid of uncertain

genus. Except that the central spine (style) is the longest of the three, and the stylets have smooth edges, this little fossil might be matched with C. E. Beecher's *Elymocaris siliqua*, p. 13, pl. 2, fig. 1, of the 'Report Geol. Surv. Penns.' 1884. The segment (about 8 mm.) was described by Mr. D. Sharpe as "simple and rounded;" the spines as "lancet-shaped," . . . "the middle one somewhat rounded and twice as long as the lateral plates, which are nearly flat." . . . "From the upper division of the Lower Silurian formation at Sazes, in the Serra de Bussaco, near Coimbra." Collected by Senhor Carlos Ribeiro. In the Geological Society's Museum, Cabinet 11, Drawer P.

This set of spines is much stouter than the specimens Mus. Pract. Geol. D $\frac{22}{14}$, Pl. XI, fig. 10, and both stouter and shorter than the somewhat similar small set in the Owens College Museum (Pl. X, fig. 11).

The telson is relatively short (about 10 mm.), smooth, ridged along the middle, having a triangular section, and rimmed at the edges. The stylets (about 6 mm. long) are strong, smooth, and rather thickened towards their outer edges.

This foreign (Portuguese) form, being within our reach, has been studied in the Geological Society's Museum, Burlington House, and shows some interesting features. Its scientific name was given by the late Mr. D. Sharpe under the supposition that the fossil was a *Dithyrocaris* with a longer abdomen than usual; but its smooth and long ultimate segment, and its smooth style, seem to remove it from that genus, as intimated in our 'Third Report,' p. 354. It is probably distinct also from *Ceratiocaris;* it has some analogy with the Devonian *Elymocaris;* but at present we cannot fix its generic place.

The caudal extremity of *Ceratiocaris aculeata*, J. Hall ('Geol. Surv. New York,' vol. iii, part i, 1859, p. 422*, and part ii, 1861, pl. 80A, fig. 10), from the "Waterlime Group," offers some alliance with this Portuguese form, though of much larger size; for its style appears to be short and strong, with a median ridge.

This interesting little Portuguese fossil is contained in a small nodule (27 × 23 mm.), broken open, dark grey within and ochreous outside; not calcareous; containing several scattered minute *Primitiæ* (?). Around the central fossil the matrix is blacker and rougher in section (limonitic).

On the face of each half is the hollow cast of a nearly cylindrical, but slightly tapering, tubular ultimate segment, 7 mm. long, by 5 mm. at the top, and 3 mm. at its end, succeeded by a style or telson, 10 mm. long in the specimen, but not quite perfect. Ochreous casts and impressions of the upper and lower parts of the style are preserved in the nodule; and they show that the style had a definitely triangular section, with a ridge on its outer face, and slightly raised rims along the edges.

By the side of the telson are two blade-like stylets, neither perfect (6 mm. long, as preserved), smooth and flattish, but thicker along their outer half.

There are also known some doubtful British forms that have been referred to *Ceratiocaris*, for illustrations of which we direct attention to the figures given with the original descriptions (see below).

29. Ceratiocaris decora (*Phillips*), 1848.

1848.	Onchus decorus, *Phillips*.		Mem. Geol. Surv., vol. ii, part 1, p. 226, pl. 30, figs. 5, 5 *a*.
1860.	Ceratiocaris decorus, *Salter*.		Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 158.
1867.	—	— —	In Siluria, 3rd (4th) edit., p. 516.
1877.	—	— *H. Woodward*.	Cat. Brit. Foss. Crust., p. 70.
1885.	—	decora, *T. R. J. & H. W.*	Third Rep. Foss. Phyll., p. 350; Geol. Mag., 1885, p. 465.

A small obscure telson (?), 13 mm. long; according to Phillips from the Upper Ludlow with Fish-defences (*Onchi*) either near Mathon Lodge, or at Hales End, in the Malvern district; but according to Salter from the "Ludlow rock of Freshwater East, Pembrokeshire."

30. Ceratiocaris (?) lata, *Salter*, 1866.

1866.	Hymenocaris ? latus, *Salter*.		Mem. Geol. Surv., vol. iii, p. 240.
1866.	Ceratiocaris ?	— —	Ibid., p. 294, woodcut fig. 5.
1867.	—	— —	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	— —	Cat. Camb. Sil. Foss., p. 16.
1877.	—	— *H. Woodward*.	Cat. Brit. Foss. Crust., p. 71.
1885.	—	lata, *T. R. J. & H. W.*	Third Report, p. 351; Geol. Mag., 1885, p. 465.

The specimen is in the Cambridge Museum (*b*/299), and shows five (?) abdominal segments crushed endwise, so as to be shortened (12 mm.) and widened (28 mm.). The woodcut referred to is a *restoration*. The specific and even generic relationship is obscure, perhaps nearest to *Hymenocaris*. From the Upper-Tremadoc Slate at Garth, east of Portmadoc; collected by Mr. D. Homfray.

31. Ceratiocaris (?) insperata, *Salter*, 1866.

1866.	Ceratiocaris ? insperatus, *Salter*.	Mem. Geol. Surv., vol. iii, p. 295, woodcut, fig. 6.
1867.	— — —	In Siluria, 3rd (4th) edit., p. 516.
1873.	— — —	Cat. C. S. Foss. Cambridge, p. 16.
1877.	— — *H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1885.	— insperata, *T. R. J. & H. W.*	Third Report, p. 351 ; Geol. Mag., 1885, p. 466.

In the Cambridge Museum (*b*/343), not well figured in the woodcut referred to, is an obscure remnant of an ultimate abdominal segment, with clear indications of a trifid appendage ; the telson or central spine seems to be the longest, but all three are broken off above their points. The telson is about 35 mm. long. From dark-grey shales between the Lower and Upper-Tremadoc Slates in a railway-cutting above the village of Penmorfa, Portmadoc. Collected by Mr. D. Homfray. Mr. Salter thought that it belonged to the same species as the foregoing.

32. Ceratiocaris (?).

An obscure hinder moiety (25×12 mm.) of a carapace possibly referable to *Ceratiocaris* is in the Mus. Pract. Geol., $\frac{13}{84}$, 'Catal. C. S. Foss.,' 1878, p. 72. From the "Upper Llandovery ; Onny River." 'Third Report Foss. Pal. Phyll.,' 1885, p. 352 ; 'Geol. Mag.,' 1885, p. 466.

33. Ceratiocaris (?) perornata, *Salter*, 1878.

1878.	Ceratiocaris perornatus (Salter MS.), *Huxley, Newton, and Etheridge.*	Catal. Camb. Sil. Foss. M. P. G., p. 142.
1885.	— ? perornata, *T. R. J. & H. W.*	Third Report, p. 352 ; Geol. Mag., 1885, p. 466.

Very little is known of this obscure form. One specimen, M. P. G. x $\frac{1}{11}$, and two in the Cambridge Museum, are only fragments (one rather more than an inch long, and the others less) of what seem to be cylindrical spines (like those of Echinoderms), about 5 mm. in diameter, two pitted all over (?) and one tuberculate. They are from the Upper Ludlow of Benson Knot, near Kendal, Westmoreland.

II. Genus Xiphocaris, *T. R. J. & H. W.*, 1886.

Ceratiocaris (?), *Salter, T. R. J. & H. W.*
Xiphocaris, *T. R. J. & H. W.*

Known only by its long, curved, blade-like telson.

1. Xiphocaris ensis (*Salter*), 1860. Pl. V, figs. 7 *a*, 7 *b*, 7 *c*, 7 *d*.

1860.	Ceratiocaris ?	ensis,	*Salter*.	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 159.
1867.	—	—	—	In Siluria, 3rd edit., p. 516.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., p. 351; Geol. Mag., 1885, p. 465.
1886.	Xiphocaris	—	—	Fourth Report, p. 233; Geol. Mag., 1886, p. 460.

In the Oxford Museum we find the original fossil described by Mr. Salter in 1860, namely specimen O, a large telson (Pl. V, fig. 7 *a*), nearly 6 inches long, lying on its side and flattened, bulbous at its proximal end, sword-shaped, with an incurved apex, a crenato-serrate convex dorsal margin, and nearly flat sides, which have a sub-central rib, giving a lozenge-shaped section (fig. 7 *b*). Not quite perfect at the point, this telson is 145 mm. long, 16 mm. broad at the bulb, and 13 mm. below it. The subcentral line is a low ridge at the top. This is traceable nearer the outside lower down; and it becomes a central furrow below. Traces of test remain here and there. Both edges are minutely serrated (figs. 7 *c* and 7 *d*). Along and close to the inner (concave) edge there is a multiple row of pits (the bases of the small spines or prickles), in threes and fours, obliquely set along the upper half, below the bulbous portion; and these are feebler and fewer lower down, and die out downwards in a less regular, thinner, and more scattered series, until they become an irregular row of single pits. Coarsely granular, radiating, and other markings, due to casts of parasitic Polyzoa, cover the bulb and occur here and there on the spine itself. The lowest portion is smooth.

The arrangement of the pitting along the concave edge may by itself indicate a distinct *generic* relationship. It reminds us of Barrande's *C. debilis,* as figured in his 'Sil. Syst. Bohême,' vol. i, Suppl. pl. 18, figs. 26—28, and pl. 31, fig. 16—19. Altogether its large size, its curvature, and the serration on both the upper and the lower edge, and the profuse spination (as shown by pits) on the latter

distinguish our fossil from other telsons; and more particularly its lozenge-shaped sectional area of an unequal rhombic form, blunter at the outer (upper) and convex edge than on the other, the ridge along the sides not being quite on the medial line, but nearer the outer than the inner edge. Neither the carapace nor the stylets of this species are known as yet. We have proposed the name Xiphocaris[1] for this rare genus.

M. Barrande's *Ceratiocaris primula* (see our 'Third Report,' p. 357) has a style (or stylet?) with lozenge- or diamond-shaped section; but, though curved, it is of different dimensions and is pitted all over.

Pl. V, fig. 7. Oxford Museum O (Grindrod Collection). Collected by Mr. A. Marston; marked "*Cerat. ensis*;" from the Lower Ludlow series at Leintwardine, Shropshire, according to Mr. Salter ('Ann. Mag.,' *l. c*).

In hard, grey, micaceous mudstone, with a few small, obscure, organic markings; calcareous at the edge.

There is another similar but much less distinct specimen of *Xiph. ensis* in the Oxford collection, from near Ludlow.

III. Genus Physocaris, *Salter*, 1860.

Ceratiocaris, *Salter*.
Physocaris, *Salter*, *T. R. J. & H. W.*

Known only by a unique specimen of an orbicular, probably bladder-like, small, thin carapace, with its abdomen and caudal appendages.

1. Physocaris vesica, *Salter*, 1860. Pl. VII, figs. 8 *a*, 8 *b*.

1860. Ceratiocaris (Physocaris) vesica, *Salter*. Ann. Mag. Nat. Hist., ser. 3. vol. v, p. 159, woodcut fig.
1865. — — — *Salter & H. Woodward*. Chart Foss. Crust., p. 17, fig. 8.
1865. — — — *Huxley & Etheridge*. Catal. Foss. M. P. G., p. 79.
1867. — vesica, *Salter*. In Siluria, 3rd (4th) edit., p. 517.
1877. — (Physocaris) vesica, *H. Woodward*. Cat. Brit. Foss. Crust., p. 72.
1878. — vesica, *Huxley, Newton, & Eth*. Cat. Foss. M. P. G., p. 142.
1884. — — *La Touche*. Handbook Geol. Shropsh., pl. 22, fig. 816.

[1] Ξίφος, a sword; καρίς, a shrimp.

1885. PHYSOCARIS VESICA, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 353; Geol. Mag., 1885, p. 467.
1886. — — — Fourth Report, p. 233; Geol. Mag., 1886, p. 460.

Of this curious fossil Phyllopod, having a small bladder-like carapace, described by Mr. Salter in 1860, only one specimen is known. It is in Mr. Theodore Salwey's collection at Ludlow. It differs slightly from Mr. Salter's woodcut figure, being larger, and showing an appearance of having been broken away to a little extent near one end so as to leave a broad notch at the slope behind an angle, and these together constitute the prominence in Mr. Salter's woodcut figure. If continued over this notch, the outline of the shell would be nearly that of a broad oval, whereas now it is broadly and obliquely pyriform (25 × 18 mm).

This specimen of *Physocaris vesica*, Salter, we consider as having had its abdominal segments shifted further upwards, and turned over on their axis, after death; and therefore as having been figured both by Mr. Salter, and in Pl. VII, fig. 8, upside down. The annexed woodcut shows what we consider to have been the natural position of the carapace and abdomen.

The relative position of the animal in these Phyllopods is indicated by the telson occupying the upper part of the caudal appendages attached to the abdomen. In this instance, however, the abdomen[1] has been twisted about, so as to be in a reversed position. There are seven exposed segments of the abdomen, which appears to come out from the lower and hinder quarter of the carapace but really (being inverted) from the upper postero-dorsal edge. From the imperfect preservation of some of the segments, the abdomen (16 mm. long) seems to be very slender near its origin, but higher at its ultimate segment (which is 7 mm. long). The proximal abdominal segments are only partly exposed; hence their narrowness is accidental and not a feature. The telson is 11 mm. long. One lateral spine (stylet), 7 mm., is present. The whole animal had a length of about two inches.

It was collected by the late Mr. Salwey in the Lower Ludlow at Leintwardine; and Mr. Salter at first labelled it as *Ceratiocaris inflatus*.

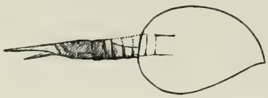


FIG. 3.—The probably true position of the carapace and abdomen in *Physocaris vesica.*

Pl. VII, figs. 8 *a*, 8 *b*. Carapace figured upside down; in olive-grey, micaceous sandstone, not calcareous; with scattered casts of small Brachiopods and Bivalves, as well as *Polyzoa*, *Beyrichia Kloedeni*, and other little fossils on a plane of

[1] The abdomen in Pl. XII, fig. 1, is also not only shifted but upside down.

bedding. There are also two fragments of abdominal segments of *Ceratiocaris;* one somewhat like Pl. III, fig. 4 *b*, and Pl. V, fig. 6 *b*. See Pl. IX, fig. 4.

A brown, much wrinkled film represents the carapace, which has been slightly broken or rather crushed in at the edge near one end, so that the exact outline there cannot be accurately defined.

Seven abdominal segments, striated across with delicate oblique lines (much like those on either half of fig. 10*b*), and a style with one stylet, are attached to the carapace. These are drawn in fig. 8*a* (as also formerly by Mr. Salter; see fig. 8 *b*) as if the appendages were in their normal position; but we think that the abdomen and spines have been twisted round and somewhat displaced since death. If they really retain their original relative position, the carapace had very unusual proportions in its dorsal and ventral curvatures. If, however, the abdomen and appendages have been inverted, the figs. 8 *a* and 8 *b* are upside down,—it is the right-hand and not the left-hand valve that is exposed,—the apiculate end should be on right hand of the observer,—and the slightly broken, hollow slope would be analogous to the antero-ventral ogee curve in such carapaces as fig. 6 on the same plate.

Fig. 8 *b* is a copy of Mr. Salter's woodcut figure of this specimen in the 'Ann. Mag. Nat. Hist.,' ser. 3, vol. v, 1860, p. 159. The figured beak-like process at the front end is not borne out by the specimen (fig. 8 *a*); and the narrow part of the abdomen is where it is still partly embedded. Mr. Salter observes that "this curious bladder-like species may very likely become the type of a new genus, in which case *Physocaris* would seem appropriate;" and he gives "*Cerat.* (*Physocaris*) *vesica*" as the title of his woodcut.

IV. Genus Emmelezoe, *T. R. J. & H. W.*, 1886.

Ceratiocaris, *M'Coy, Morris, Salter, Woodward.*
Ceratiocaris?, *T. R. J. & H. W.*
Emmelezoe, *T. R. J. & H. W.*

Ovate-oblong, boat-shaped carapace, striate and bearing an ocular tubercle.

1. Emmelezoe elliptica (*M'Coy*), 1849. Pl. VIII, figs. 1 *a*, 1 *b*.

1849.	Ceratiocaris	ellipticus,	*M'Coy.*	Ann. Mag. Nat. Hist.,' ser. 2, vol. iv, p. 413.
1851.	—	—	—	Brit. Pal. Foss., fasc. i, p. 137, pl. 1 E, fig. 8.
1854.	—	—	*Morris.*	Catal. Brit. Foss., 2nd edit., p. 103.

1859.	CERATIOCARIS	ELLIPTICUS,	*Salter.*	In Siluria, 2nd (3rd) edit., p. 538.
1860.	—	—	—	Ann. M. N. H., ser. 3, vol. v, p. 157.
1867.	—	—	—	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	—	—	Catal. Camb. Sil. Foss., p. 178.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1885.	— ?	ELLIPTICA,	*T. R. J. & H. W.*	Third Report Foss. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886.	EMMELEZOE	—	—	Fourth Report, p. 232; Geol. Mag., 1886, pp. 459, 460.

This interesting species, one of the first two established, is represented in the Cambridge Museum by specimen *b*/15 (the same as M'Coy's fig. 8 reversed). The carapace is elongate, sub-ovate or suboblong in outline, convex medially, with the greatest convexity of surface and curvature of ventral margin "at about one-third from the anterior end;" obliquely rounded in front; obliquely truncate at the upper portion of the hinder end, which rounds off from the ventral margin below, and slopes up to the blunt postero-dorsal angle above. The back is straight; the lower margin neatly curved. The valve measures 32 mm. long and 13 mm. high. There is a spot like a definite ocular tubercle in the anterior fourth and above the median line of each valve, and this gives it a distant likeness to a guinea-pig's profile. The spot is a small round tubercle, at about a sixth of the valve's length from the front, and a sixth of the height from the back. The surface is neatly marked with delicate, longitudinal, parallel lines, rather far apart. The figure of the specimen *b*/15, published in 1851, is reversed, and drawn too angular behind. It came from the Upper Ludlow sandstone of Benson Knot.

In 1860 Mr. Salter thought that *C. elliptica* was only a badly preserved variety of *C. inornata* ('A. M. N. H.' *l. c.*), but in the 'Catal. Cambr. Sil. Foss.,' p. 178, he recognised it as "quite distinct."

As intimated in our 'Third Report,' pp. 352, 353, the presence of the ocular tubercle has an important significance, showing that the animal must have had the organ equivalent to the eye sufficiently developed to affect the external covering, whether it was adapted for clear vision or not. It is not only a generic character distinguishing them from *Ceratiocaris*, but probably an important family distinction. At all events the oculate carapaces have to be removed from *Ceratiocaris*, and we have proposed that M'Coy's *C. elliptica* should be referred to a new genus under the name EMMELEZOE.[1]

The above-described and three other specimens supply our only evidence of an eye-spot in these Ceratiocaridoid Phyllopods.[2]

[1] 'Εμμελής, elegant; ζωή, life (a termination common in some of M. Barrande's genera).

[2] The "ocular tubercles" mentioned in the footnote at p. 236, 'Siluria,' 3rd (4th) edit., 1867, are without doubt due to the presence of "teeth" within the valves.

Pl. VIII, figs. 1 *a*, 1 *b*. This is specimen *b*/15 in the Cambridge Museum; marked "*Ceratiocaris ellipticus*, M'Coy, 'Brit. Pal. Foss,' pl. 1 E, fig. 8." It is in a dark-grey, micaceous, fine-grained, slightly calcareous sandstone of the Upper Ludlow formation; Benson Knot, Kendal.

2. Emmelezoe crassistriata, *T. R. J. & H. W.*, 1886. Pl. VIII, figs. 3 *a*, 3 *b*.

1878. Ceratiocaris Murchisoni, *Huxley, Newton, & Etheridge.* Catal. Foss. M. P. G., p. 142.
1885. — elliptica, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886. Emmelezoe crassistriata, — Fourth Report, p. 233; Geol. Mag., 1885, p. 460.

Carapace subovate; somewhat compressed, but rather convex above the median line; imperfect at the ends, but probably once bluntly pointed in front and rather above the middle line behind; back gently convex; ventral border deeply and nearly symmetrically curved. Two peculiar little round spots are present just below the middle on the ventral edge.[1] Strongly striate with parallel, longitudinal, anastomosing wrinklets, wide apart and somewhat interrupted. Ocular spot a distinct, round tubercle at one-fourth of the length of the valve from the front and one-fourth height from the back; and somewhat worn. An accidental depression occurs behind the eye-spot. The valve in profile is somewhat like the head of a Chætodon.

Mus. Pract. Geol. x $\frac{1}{10}$, Pl. VIII, figs. 3 *a*, 3 *b*, is preserved in a greenish-grey, micaceous, and somewhat calcareous Upper Ludlow sandstone, from Combe Wood, Presteign. This is larger than either *E. elliptica* or *E. tenuistriata*, and being coarsely striated has been named by us E. crassistriata.

3. Emmelezoe tenuistriata, *T. R. J. & H. W.*, 1886. Pl. VII, figs. 9 *a*, 9 *b*.

1885. Ceratiocaris elliptica, *T R. J. & H. W.* Third Report Pal. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886. Emmelezoe tenuistriata, — Fourth Report, p. 232; Geol. Mag., 1885, p. 460.

The specimen Ludlow Museum G, Pl. VII, fig. 9, is shorter and broader

[1] Two somewhat analogous spots, but further apart, are seen on the ventral margin of *Leperditia grandis.*

(higher) than *Em. Maccoyiana;* though imperfect, it seems to have been nearly semicircular in outline below with an acute and projecting postero-dorsal angle; and its surface has a fine, almost silky, linear ornament. As a new species we have called this E. TENUISTRIATA. No locality is noted; but it is probably from the Lower Ludlow series near Ludlow, in the usual greenish-grey mudstone, slightly calcareous, with a fragment of *Graptolithus priodon.* The carapace-valve is elliptical in shape, slightly arched on the back, deeply and nearly symmetrically curved below; the postero-dorsal angle is above the median line and strong. The antero-dorsal region is embedded in the matrix. The valve, brown, thin, and filmy or membrane-like, is much flattened by pressure; it is ornamented with very delicate longitudinal striæ, magnified in fig. 9, *b* (placed vertically instead of horizontally on the plate). A morsel of the browner and more solid test is visible at the antero-ventral margin; also at the broken edge of the specimen where the compressed contents of the carapace are seen to constitute a definite layer over-resting upon the opposite (embedded) valve.

In the antero-dorsal region is a small, round, raised *ocular spot.* Lower down and more behind is a rough cavity with an irregular raised rim, caused by the presence of internal organs.

4. EMMELEZOE MACCOYIANA, *T. R. J. & H. W.*, 1886. Pl. VIII, figs. 2 *a*, 2 *b*.

1878. CERATIOCARIS MURCHISONI, *Huxley, Newton, & Etheridge.* Catal. Foss. M. P. G., p. 118.
1885. — ELLIPTICA, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886. EMMELEZOE MACCOYIANA, — Fourth Report, p. 233; Geol. Mag., 1886, p. 460.

Carapace-valve boat-shaped, narrow-elliptical, smooth, longitudinally striate, with the lines rather wide apart. In general character like Pl. VIII, fig. 3, but smaller and much narrower in proportion. Much flattened by pressure. Not so large as in fig. 1, and differing from it in both anterior and posterior outlines.

This specimen, M. P. G. $\frac{23}{32}$, smaller than either *E. elliptica* or *E. crassistriata*, is somewhat boat-shaped, and between the two above-mentioned in shape but not identical with either; and it is rather coarsely striated longitudinally. To this form we have given the name E. MACCOYIANA in honour of the first describer of any member of the genus.

The specimen is from Leintwardine (Lower Ludlow), in brownish-grey, micaceous mudstone, calcareous along thin streaks at the edge.

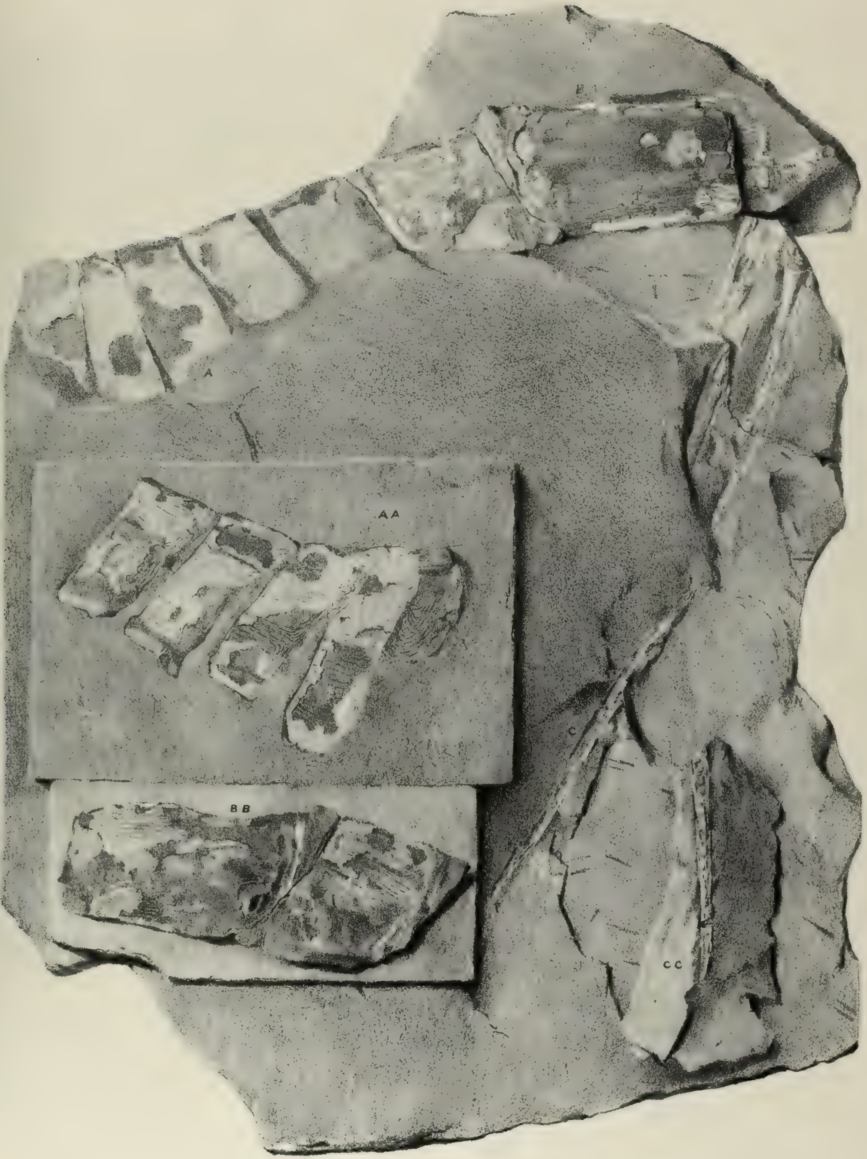
LIST OF THE PALÆOZOIC PHYLLOCARIDA DESCRIBED IN THIS MONOGRAPH: PART I.

	Carboniferous Limestone; Oreton.	Ludlow Beds.				Wenlock Beds.		Upper Llandovery; Onny River.	Tremadoc Slates; Portmadoc.
		Upper Ludlow; Ludlow.	Upper Ludlow; Benson Knot, Kendal.	Upper Ludlow; Lesmahago, or Muirkirk.	Lower Ludlow; at and near Ludlow.	Dudley, Welshpool, or Kirkby-Lonsdale, &c.	Lower Wenlock; Helm Knot, Dent.		
1. Ceratiocaris leptodactylus ...	...	...	...	...	×	...	×		
2. — Murchisoni	...	×	...	...	×	×			
3. — valida	...	..	...	...	...	×			
4. — tyrannus	...	...	...	...	×				
5. — gigas...............	...	...	...	..	× & Knighton	×			
6. — Halliana	...	...	...	...	×				
7. — Pardoëana	...	...	...	...	×				
8. — canaliculata	...	×							
9. — Ludensis	...	...	...	...	×				
10. — papilio	...	...	×	×	×				
11. — stygia	...	...	×	×	×				
12. — longa...............	...	?	...	...	×				
13. — robusta............	...	...	...	×	×				
14. — patula	...	...	...	...	×				
15. — angusta............	...	...	...	×					
16. — minuta	...	...	...	...	×				
17. — inornata	...	...	×	×					
18. — Ruthveniana ...	...	...	×						
19. — Oretonensis	×								
20. — truncata	×								
21. — solenoides	...	...	×						
22. — gobiiformis	...	...	×						
23. — Salteriana.........	...	...	...	...	× & Dudley				
24. — laxa	...	...	...	×					
25. — compta	...	...	...	...	×				
26. — cassia	...	...	...	...	×				
27. — cassioides	...	...	...	...	×				
28. — ? longicauda (D. Sharpe). Lower Silurian; Portugal.									
29. — ? decora	...	× & Malvern	...	...	?				
30. — ? lata...............	...	...	...	...	...	...	...	...	×
31. — ? insperata	...	...	...	...	...	...	...	...	×
32. — ? sp.	...	...	...	...	...	...	...	×	
33. — perornata	...	...	×						
34. Xiphocaris ensis	...	...	...	...	×				
35. Physocaris vesica	...	...	...	...	×				
36. Emmelezoe elliptica	...	...	×						
37. — crassistriata	...	Presteign							
38. — Maccoyiana	...	...	...	...	×				
39. — tenuistriata	...	...	...	...	×				

PLATE I.

Ceratiocaris Ludensis, *H. Woodward.*

Seven abdominal segments, and imperfect caudal spines. With three portions shown in reverse. Two-thirds of the natural size. See also Plate IX, fig. 1 *a*, natural size. Ludlow Museum. (Page 32.)



A. B. Woodward del et lith

West, Newman & C° imp.

BRITISH FOSSIL PHYLLOPODA

PLATE II.

Ceratiocaris Halliana, *T. R. J. & H. W.* Natural size.

Fig. 1.—Carapace. Mus. Pract. Geol. (Page 26.)

Fig. 2.—Carapace, segments, and a portion of the appendages. Mus. Pract. Geol. (Page 27.)

Fig. 3.—Carapace and segments. Mus. Pract. Geol. (Page 28.)

Fig. 4.—The same (?). Carapace, segments, and caudal appendages. (Possibly *C. tyrannus.*) Mus. Pract. Geol. (Page 27.)

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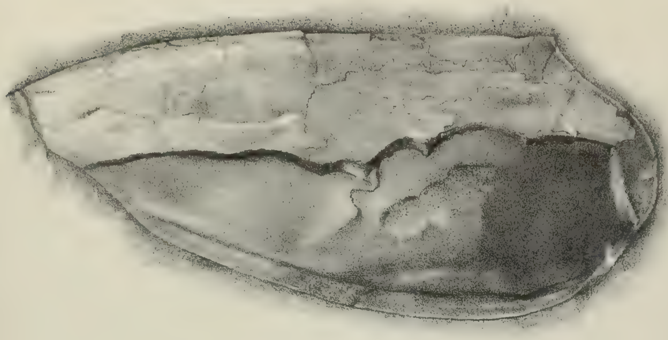

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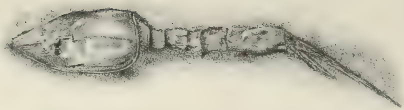


G. M. Woodward del. et lith.

West, Newman & C° imp.

BRITISH FOSSIL PHYLLOPODA

PLATE III.

(All the figures are of natural size except fig. 4 *b*, which is one and a half natural size.)

Fig. 1.—*Ceratiocaris gigas*, Salter. Ultimate segment and a portion of the appendages. Mus. Pract. Geol. (Page 24.)

Fig. 2.—*C. tyrannus,* Salter. Four segments and the distal portion of the appendages. Mus. Pract. Geol. (Page 22.)

Fig. 3.—The same. Four segments and the proximal portion of style and stylet. Mus. Pract. Geol. (Page 23.)

Fig. 4.—*C. Murchisoni* (Agassiz). 4 *a*, four segments and appendages ; 4 *b*, one of the segments enlarged (half as much again) to show its ornament. Mus. Pract. Geol. (Page 16.)

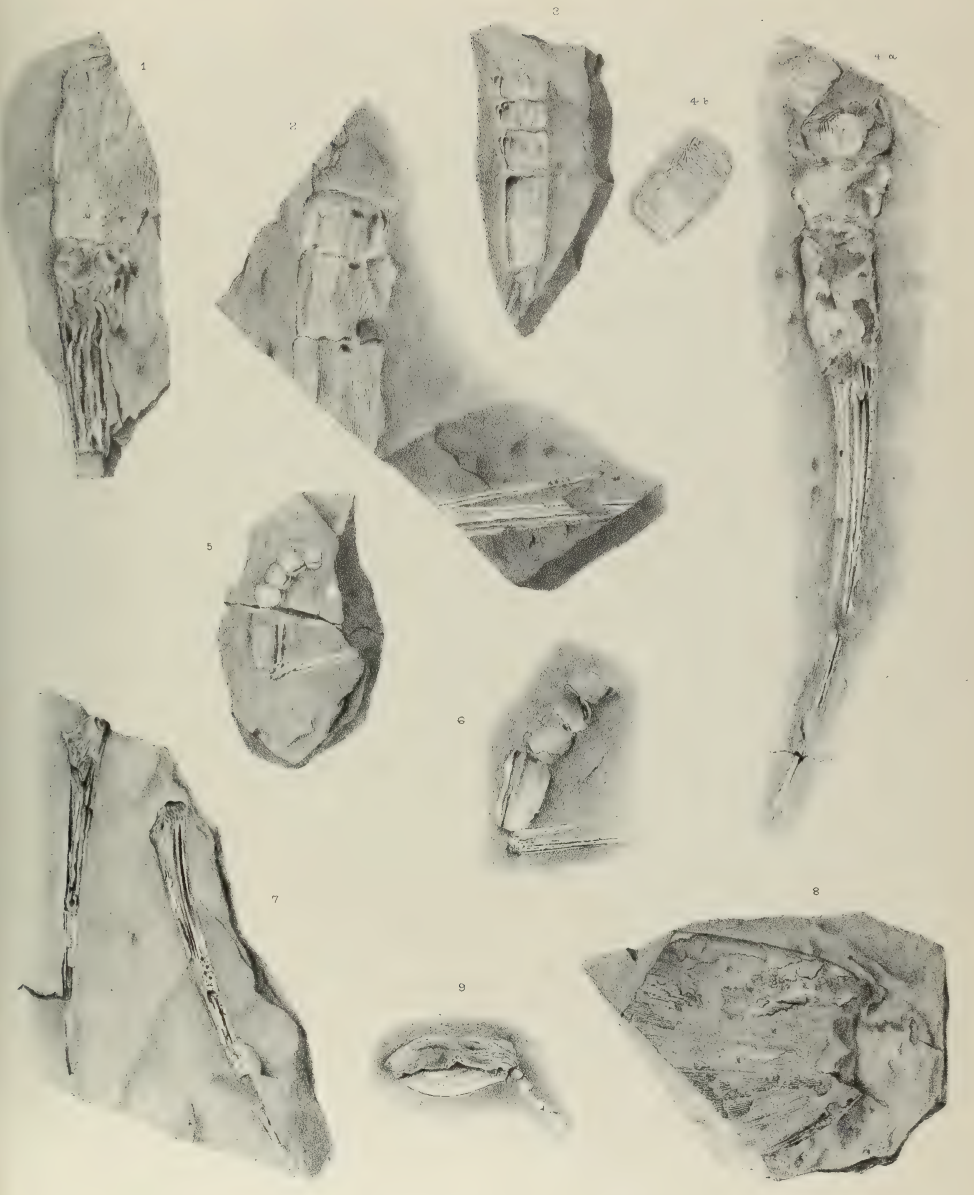
Fig. 5.—*C. tyrannus*, Salter. Small ; five segments and imperfect appendages. Mus. Pract. Geol. (Page 23.)

Fig. 6.—The same. Small ; four segments and the appendages. British Museum. (Page 23.)

Fig. 7.—*C. Murchisoni* (Agassiz). Two stylets. Mus. Pract. Geol. (Page 18.)

Fig. 8.—*C. tyrannus* (*?*), Salter. Fragment of the anterior moiety of a right valve. Mus. Pract. Geol. (Page 23.)

Fig. 9.—*C. cassioides*, T. R. J. & H. W. Carapace and imperfect abdominal segments. British Museum. (Page 59.)



E C Knight del.et lith

West, Newman & Co imp

BRITISH FOSSIL PHYLLOPODA.

PLATE IV.

(All the figures are of the natural size.)

Fig. 1.—*Ceratiocaris Murchisoni* (Agassiz). The three caudal spines. Oxford Mus. (Page 18.)

Fig. 2.—*C. gigas*, Salter. Ultimate segment and the appendages, not quite perfect. Oxford Mus. (Page 25.)

Fig. 3.—*C. Murchisoni* (Agassiz). The three appendages, not quite perfect. Oxford Mus. (Page 19.)

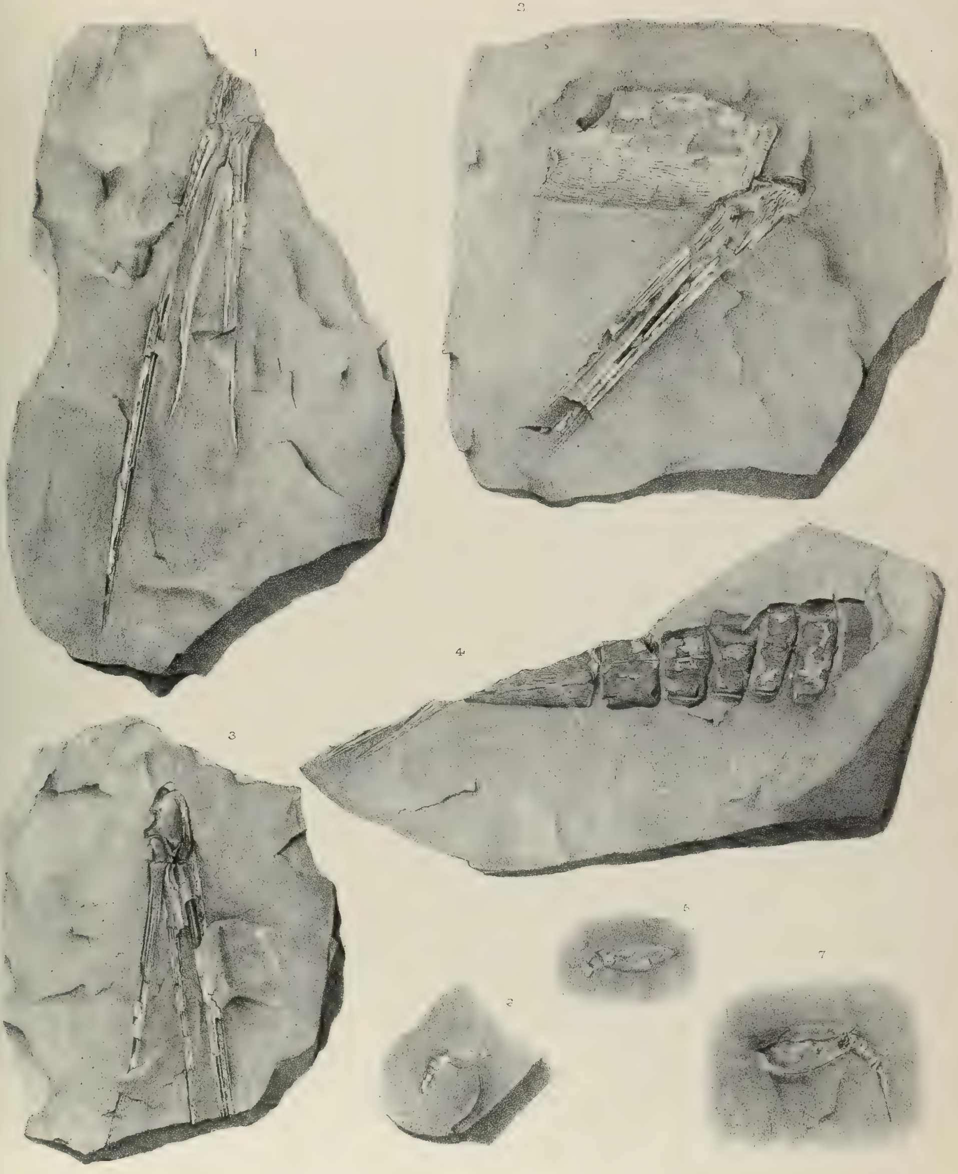
Fig. 4.—*C. tyrannus*, Salter. Seven segments, and fragments of the appendages. Oxford Mus. (Page 23.)

Fig. 5.—*C. Halliana* (*?*), T. R. J. & H. W. Very small. Carapace and two segments. Oxford Mus. (Page 29.)

Fig. 6.—The same (?). T. R. J. & H. W. Very small. Carapace and six segments. Oxford Mus. (Page 29.)

Fig. 7.—*C. cassioides*, T. R. J. & H. W. Carapace, four segments, and telson. Oxford Mus. (Page 60.)

PLATE IV.



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BRITISH FOSSIL PHYLLOPODA

PLATE V.

(All the figures are of the natural size except fig. 6 *b*, which is magnified three and a half times, and 7 *c* and 7 *d*.)

Fig. 1.—*Ceratiocaris Pardoëana*, La Touche. Carapace (with rostrum), six (?) segments, and proximal portion of the caudal appendages. Ludlow Mus. (Page 30.)

Fig. 2.—The same. Carapace and six segments, with the proximal portion of the caudal spines. Ludlow Mus. (Page 31.)

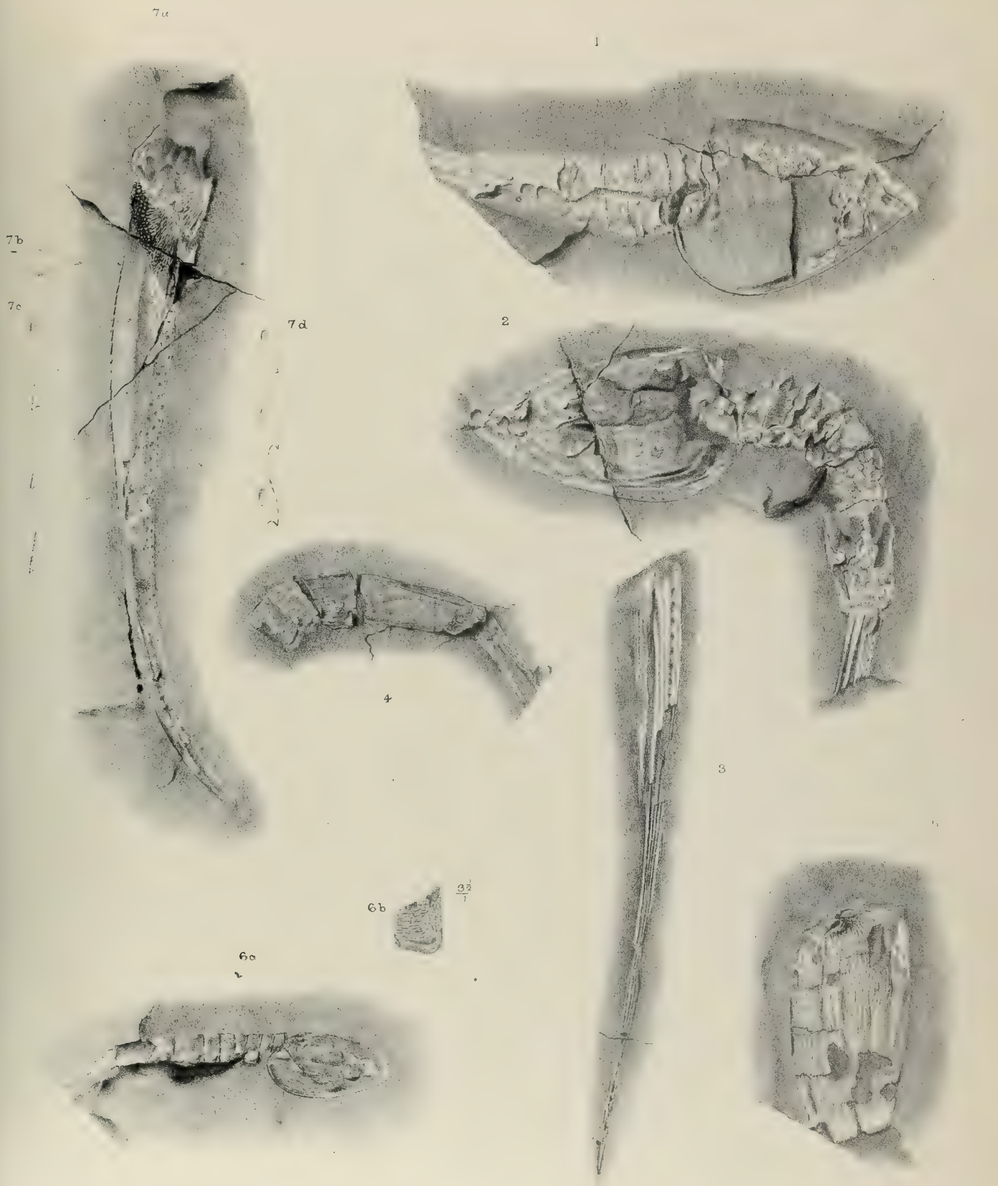
Fig. 3.—*C. Murchisoni* (Agassiz). Caudal spines, imperfect. Ludlow Mus. (Page 19.)

Fig. 4.—*C. tyrannus*, Salter. Four segments and imperfect caudal appendages. Ludlow Mus. (Page 24.)

Fig. 5.—*C. gigas*, Salter. Ultimate segment. Ludlow Mus. (Page 25.)

Fig. 6.—*C. Halliana* (?), T. R. J. & H. W. Small. 6 *a*. Carapace, eight segments, and caudal spines, imperfect. (Possibly *C. tyrannus.*) Ludlow Mus. 6 *b*, part of a segment enlarged ($3\frac{1}{2}$ diameters) to show the ornament. (Pages 22 and 29).

Fig. 7.—*Xiphocaris ensis* (Salter). 7 *a*, the telson; 7 *b*, its sectional area; 7 *c*, enlarged border of the convex edge; 7 *d*, enlarged border of the concave edge. (Page 65.)



E. C. Knight del et lith

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BRITISH FOSSIL PHYLLO[illegible]A.

PLATE VI.

(All the figures are of the natural size except fig. 4 *b*, magnified 3 diameters, and fig. 4 *c*, 2 diameters.)

Fig. 1.—*Ceratiocaris Murchisoni* (Agassiz). (Type specimen.) Broken caudal spines, copied from 'Siluria,' 1867, pl. 19, fig. 1. (Specimen lost.) (Page 19.)

Fig. 2.—The same. Imperfect head of a telson. Copied from 'Siluria,' 1867, pl. 19, fig. 2. (Specimen lost.) (Page 19.)

Fig. 3.—*C. longa* (?), T. R. J. & H. W. A stylet. Copied from 'Siluria,' 1867, pl. 19, fig. 3. (Specimen lost.) (Page 43.)

Fig. 4.—*C. leptodactylus*, M'Coy. (Type specimen, fig. 7 in 'Brit. Pal. Foss.,' 1855.) 4 *a*, a telson with piece of the ultimate segment; 4 *b*, portion of the telson, with pits, enlarged 3 diameters; 4 *c*, enforced contact of the telson and ultimate segment, magnified 2 diameters. Cambridge Mus. (Page 15.)

Fig. 5.—*C. leptodactylus*, M'Coy. (Original of fig. 7 *a* in 'Brit. Pal. Foss.,' 1855.) A telson, imperfect. Cambridge Mus. (Page 15.)

Fig. 6.—The same. Part of an ultimate segment and of a telson (?). Mus. Pract. Geol. (Page 15.)

Fig. 7.—The same. Three caudal spines, not quite perfect. Mus. Pract. Geol. (Page 15.)

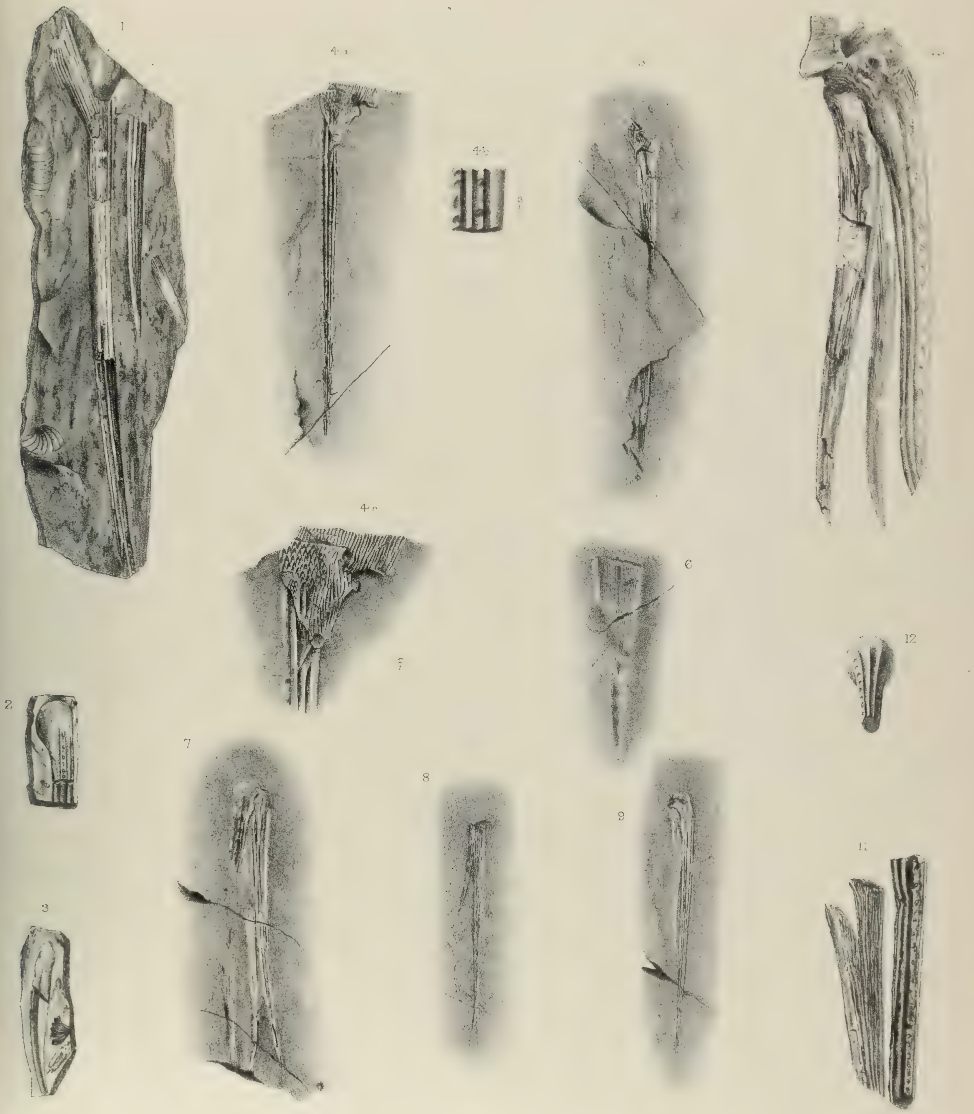
Fig. 8.—The same. Caudal spines, imperfect. Mus. Pract. Geol. (Page 16.)

Fig. 9.—The same. Style and stylet. Mus. Pract. Geol. (Page 16.)

Fig. 10.—*C. valida*, T. R. J. & H. W. Three caudal spines (not quite perfect), with a fragment of the ultimate segment. Copied from the 'Geol. Mag.,' vol. iii, pl. 10, fig. 8. Dudley Mus. (Page 21.)

Fig. 11.—The same. Portion of three caudal spines. Copied from the 'Geol. Mag.,' vol. iii, pl. 10, fig. 9. Mus. Pract. Geol. (Page 21.)

Fig. 12.—*C. Bohemica*, Barrande. Dorsal view of the head of a telson. Copied from the 'Geol. Mag.,' vol. iii, pl. 10, fig. 10, for comparison. British Mus. (Page 21.)



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BRITISH FOSSIL PHYLLOPODA

PLATE VII.

(All the figures are of the natural size except figs. 7 *b*, 7 *d*, 7 *e*, and 9 *b*.)

Figs. 1 *a*, 1 *b*.—*Ceratiocaris Salteriana*, T. R. J. & H. W. The counterparts of a squeezed carapace. Mus. Pract. Geol. (Page 55.)

Fig. 2.—The same. A carapace. Cambridge Mus. (Page 55.)

Fig. 3.—The same. A carapace, abdominal segments, and caudal appendages. Oxford Mus. (Page 56.)

Fig. 4.—*Ceratiocaris cassioides*, T. R. J. & H. W. Carapace, abdomen, and appendages. Ludlow Mus. (Page 60.)

Fig. 5.—The same. Carapace, abdomen, and appendages. Oxford Mus. (Page 61.)

Fig. 6.—The same. Carapace, abdomen, and appendages. Mus. Pract. Geol. (Page 60.)

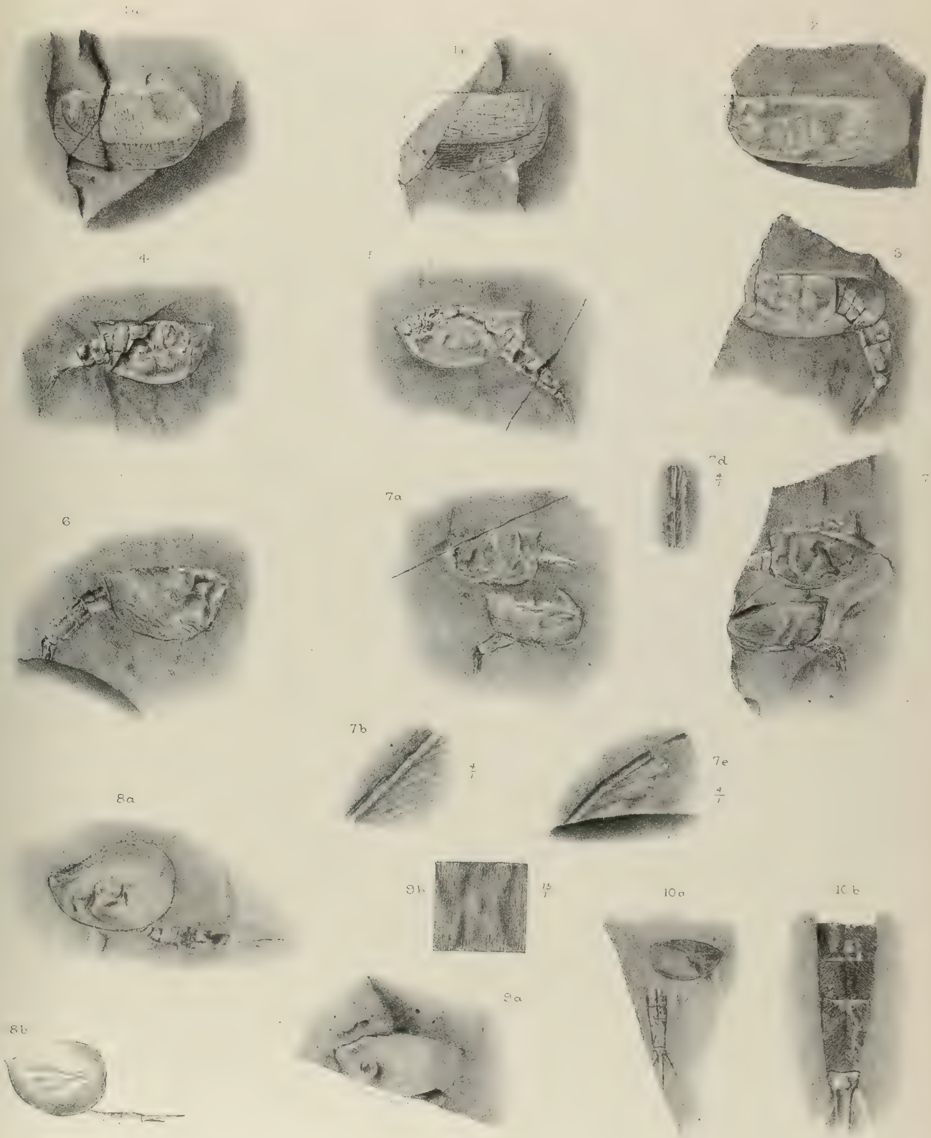
Figs. 7 *a*—7 *e*.—*Ceratiocaris cassia*, Salter. Counterparts of a small slab, each having remains of two carapaces (neither quite perfect, and the lower one narrowed by pressure) with abomen and appendages. 7 *a*, Ludlow Mus.; 7 *c*, Mus. Pract. Geol.; 7 *b* (× 4 diam.), a piece of the ventral rim and striæ from 7 *a*; 7 *d* and 7 *e* (× 4 diam.), similar pieces projecting from the upper borders of the carapaces; 7 *d*, from upper specimen in fig. 7 *c*; and 7 *e*, from the lower specimen. (Page 58.)

Fig. 8.—*Physocaris vesica*, Salter. 8 *a*, the specimen in Mr. Salway's collection at Ludlow; 8 *b*, copied from the woodcut in the 'Ann. Mag. Nat. Hist.,' 1860. In both cases the carapace is probably upside down. (Page 67.) (See also the woodcut, Page 67.)

Fig. 9.—*Emmelezoe tenuistriata*, T. R. J. & H. W. 9 *a*, carapace partly embedded above and broken below; 9 *b*, portion of the linear ornament (× 15 diam.), placed vertically instead of horizontally. Ludlow Mus. (Page 70.)

Fig. 10.—*Ceratiocaris compta*, T. R. J. & H. W. 10 *a*, remains of carapace, abdomen, and appendages; 10 *b*, part of abdomen and appendages, magnified 3 diameters. Ludlow Mus. (Page 57.)

PLATE VII.



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BRITISH FOSSIL PHYLLOPODA.

PLATE VIII.

(All the figures are of the natural size except figs. 11 *b*, 11 *c*.)

Figs. 1 *a*, 1 *b*.—*Emmelezoe elliptica*, M'Coy. 1 *a*, left valve; 1 *b*, end view. Cambridge Mus. (Page 69.)

Figs. 2 *a*, 2 *b*.—*E. Maccoyiana*, T. R. J. & H. W. 2 *a*, right valve; 2 *b*, end view. Mus. Pract. Geol. (Page 71.)

Figs. 3 *a*, 3 *b*.—*E. crassistriata*, T. R. J. & H. W. 3 *a*, right valve; 3 *b*, end view. Mus. Pract. Geol. (Page 70.)

Figs. 4 *a*, 4 *b*.—*Ceratiocaris solenoides*, M'Coy. 4 *a*, dorsal aspect of an imperfect and partly embedded carapace; 4 *b*, end view of one of the valves. Cambridge Mus. (Page 53.)

Fig. 5.—The same. Right valve partly embedded in the matrix. Cambridge Mus. (Page 53.)

Fig. 6 *a*, 6 *b*.—*C. gobiiformis*, T. R. J. & H. W. 6 *a*, right valve; 6 *b*, end view. British Mus. (Page 54.)

Figs. 7 *a*, 7 *b*.—*C. solenoides*, M'Coy. Original of fig. 5 in 'Brit. Pal. Foss.,' 1855. 7 *a*, right valve; 7 *b*, end view. Cambridge Mus. (Page 53.)

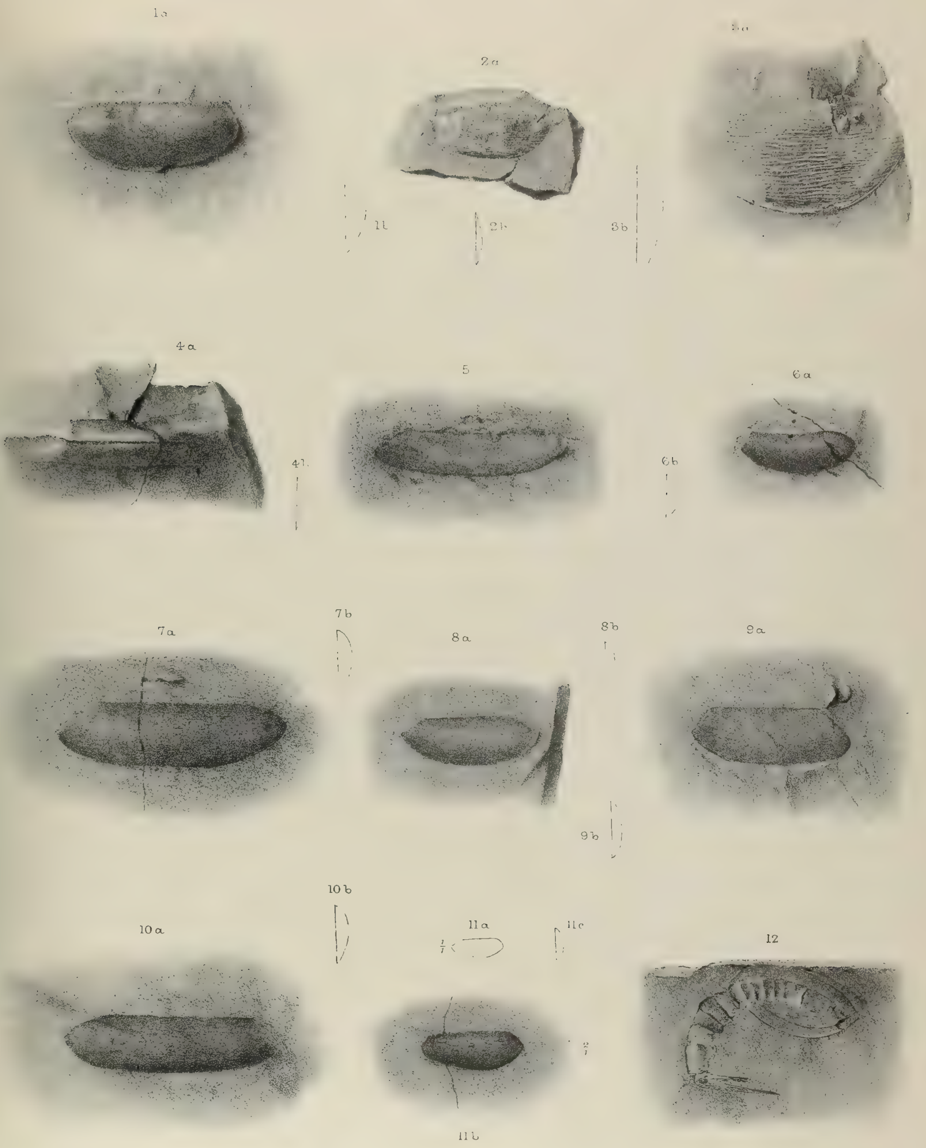
Figs. 8 *a*, 8 *b*.—The same. Short variety. 8 *a*, left valve, imperfect; 8 *b*, end view. Cambridge Mus. (Page 53.)

Figs. 9 *a*, 9 *b*.—The same. Short variety. 9 *a*, left valve, partly embedded; 9 *b*, end view. Mus. Pract. Geol. (Page 53.)

Figs. 10 *a*, 10 *b*.—The same. Long form, like 7 *a*. 10 *a*, left valve; 10 *b*, end view. Cambridge Mus. (Page 53.)

Figs. 11 *a*, 11 *b*, 11 *c*.—*C. gobiiformis*, T. R. J. & H. W. 11 *a*, right valve, natural size; 11 *b*, the same, magnified 2 diam.; 11 *c*, end view, × 2 diam. Cambridge Mus. (Page 54.)

Fig. 12.—*C. laxa*, T. R. J. & H. W. Carapace, abdomen, and caudal appendages, complete. (A piece of the delicate striation is shown, magnified 25 diam., in Plate X, fig. 12.) British Mus. (Page 56.)



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BRITISH FOSSIL PHYLLOPODA.

PLATE IX.

(All the figures are of the natural size except fig. 1 *b* and fig. 4.)

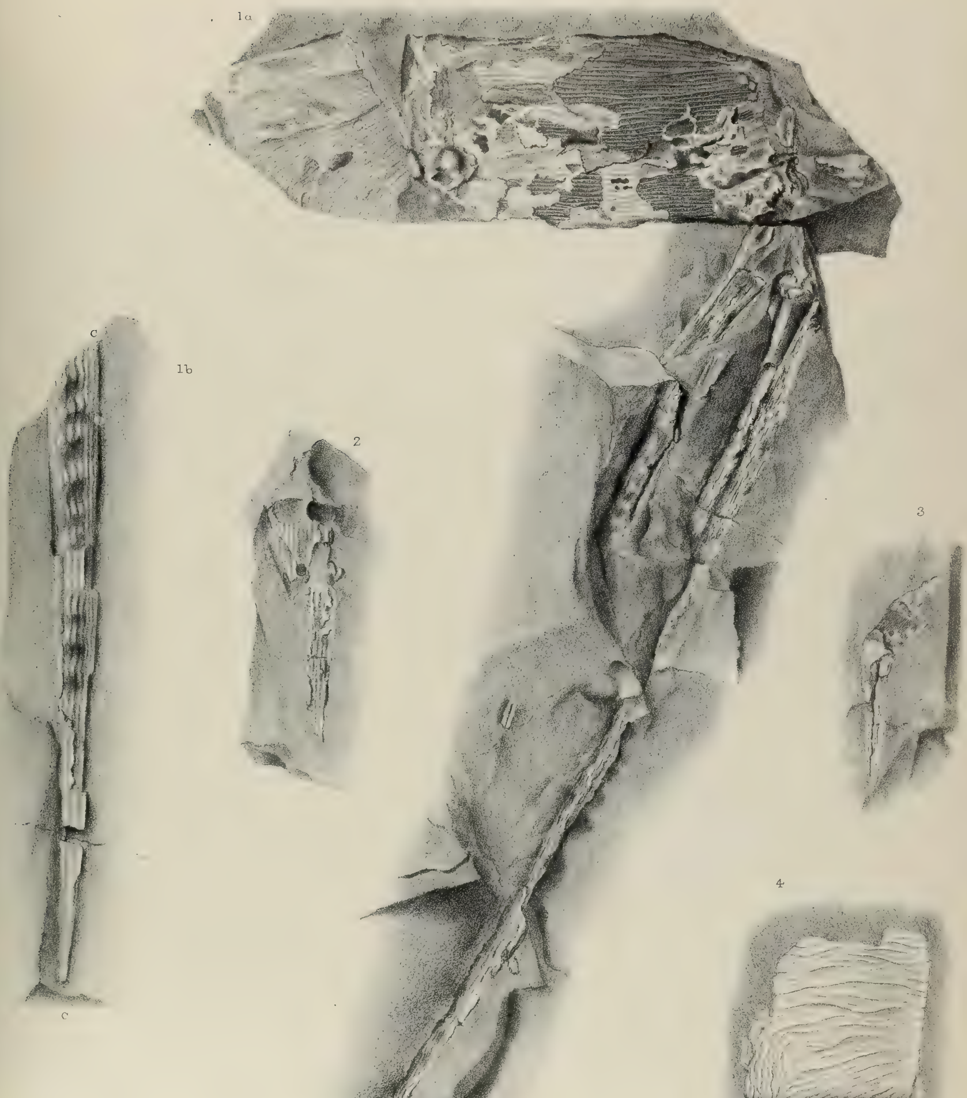
Fig. 1.—*Ceratiocaris Ludensis,* H. Woodward. (See also Plate I.) 1 *a*, two segments and the caudal appendages (imperfect) of the natural size; 1 *b*, the terminal portion of the spine E, D, C. enlarged twice. Ludlow Museum. (Page 34.)

Fig. 2.—*C. canaliculata*, T. R. J. & H. W. Upper portion of a telson, crushed and broken. Mr. Cocking's collection, Ludlow. (Page 31.)

Fig. 3.—The same. Fragments of an ultimate segment and a telson. Mus. Pract. Geol. (Page 31.)

Fig. 4.—*C. tyrannus* (*?*), Salter. An abdominal segment (imperfect), enlarged 4 diam., to show its ornament. On the back of the slab with *Physocaris vesica,* Pl. VII, fig. 8, in Mr. T. J. Salwey's collection, Ludlow. (Page 24.)

PLATE IX.



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BRITISH FOSSIL PHYLLOPODA.

PLATE X.

(All the figures are of the natural size except fig. 7 *b* and fig. 12.)

Figs. 1 *a*, 1 *b*.—*Ceratiocaris truncata*, H. Woodward. Left valve: 1 *a*, the internal cast; and 1 *b*, the hollow impression; counterparts. British Mus. (Page 51.)

Fig. 2.—*C. inornata*, M'Coy. Right valve. British Mus. (Page 48.)

Fig. 3.—The same. Right valve. The specimen figured in the 'Brit. Pal. Foss.,' 1851, fig. 4. Cambridge Mus. (Page 49.)

Fig. 4.—*C. Oretonensis*, H. Woodward. Left valve. British Mus. (Page 50.)

Fig. 5.—*C. inornata*, M'Coy. Right valve. British Mus. (Page 48.)

Fig. 6.—*C. Ruthveniana*, T. R. J. & H. W. Right valve, imperfect. British Mus. (Page 49.)

Figs. 7 *a*, *b*.—*C. stygia*, Salter var. 7 *a*, right valve; 7 *b*, portion enlarged (2 diam.) to show the longitudinal striation on the upper and lower regions of the valve. Cambridge Mus. (Page 41.)

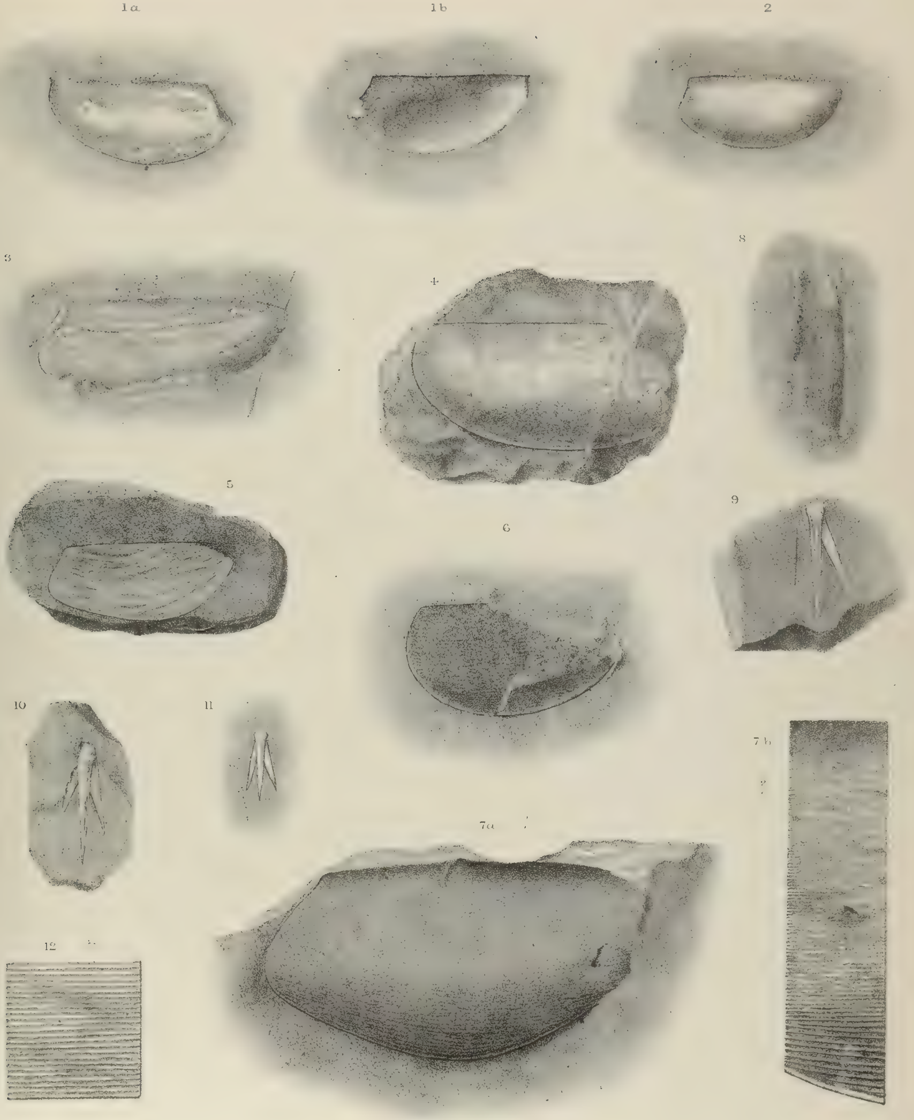
Fig. 8.—*C. leptodactylus* (?), M'Coy. Portion of the abdomen, probably part of the penultimate and ultimate segments. British Mus. (Page 16.)

Fig. 9.—*C. angusta*, T. R. J. & H. W. Style and stylet. British Mus. (Page 47.)

Fig. 10.—*C. robusta*, Salter. Trifid appendage. Mus. Pract. Geol. (Page 44.)

Fig. 11.—*C. minuta*, T. R. J. & H. W. Trifid appendage. Owens College Mus. (Page 47.)

Fig. 12.—*C. laxa*, T. R. J. & H. W. Portion of the linear ornament, magnified 25 diam. (see Pl. VIII, fig. 12). British Mus. (Page 57.)



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BRITISH FOSSIL PHYLLOPODA

PLATE XI.

(All the figures are of the natural size except figs. 4 *b*, 13 *b*, and 16 *b*.)

Fig. 1.—*Ceratiocaris stygia* (?), Salter. Two abdominal segments, with a style and a stylet, well preserved. Cambridge Mus. (Page 41.)

Fig. 2.—*C. longa*, T. R. J. & H. W. Caudal extremity (wanting one stylet), flattened. Ludlow Mus. (Page 43.)

Fig. 3.—*C. stygia*, Salter. Two abdominal segments, style, and stylet, squeezed sideways. Mus. Pract. Geol. (Page 41.)

Figs. 4 *a*, 4 *b*.—*C. papilio*, Salter. 4 *a*, four segments, style, and stylet, squeezed sideways; 4 *b*, portion of leaf-like ornament (× 3 diam.). Oxford Mus. (Page 38.)

Fig. 5.—*C. longa*, T. R. J. & H. W. One segment, style, and stylet, like fig. 2. Mus. Pract. Geol. (Page 43.)

Fig. 6.—*C. papilio*, Salter. Four segments and trifid appendage, pressed flat. British. Mus. (Page 38.)

Fig. 7.—*C. stygia*, Salter. Two segments with telson and stylet, pressed sideways. Oxford Mus. (Page 41.)

Fig. 8.—*C. robusta*, Salter. Telson and stylet, squeezed sideways. The original of fig. 7 *e*, 'Brit. Pal. Foss.,' 1851. Cambridge Mus. (Page 45.)

Fig. 9.—The same. A stylet. The original of fig. 7 *d* in the 'Brit. Pal. Foss.,' 1851. Cambridge Mus. (Page 45.)

Fig. 10.—*C. minuta* (?), T. R. J. & H. W. A trifid appendage, not quite perfect at the top. Mus. Pract. Geol. (Page 47.)

Fig. 11.—*C. patula*, T. R. J. & H. W. A flattened trifid of broad caudal spines. Oxford Mus. (Page 46.)

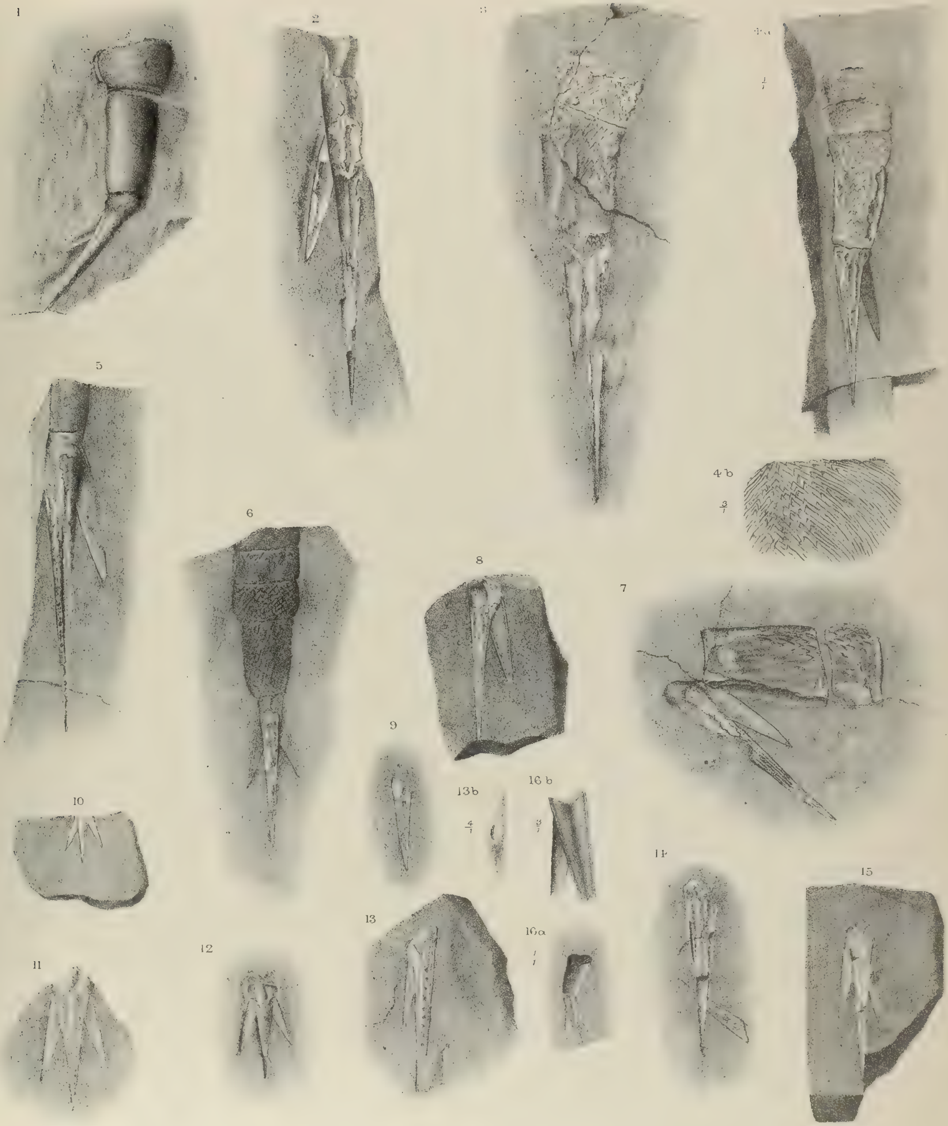
Fig. 12.—*C. robusta* (?), Salter. Cast of a trifid appendage (small). British Mus. (Page 45.)

Figs. 13 *a*, 13 *b*. *C. robusta*, Salter. 13 *a*, style and stylet, pressed sideways. 13 *b*, portion of the pitted row, magnified 3 diam. British Mus. (Page 45.)

Fig. 14.—The same. Style and displaced stylet. British Mus. (Page 45.)

Fig. 15.—The same. A perfect trifid, flattened. British Mus. (Page 46.)

Figs. 16 *a*, 16 *b*. *Ceratiocaris* (?) *longicauda*, D. Sharpe. Portugese specimen. 16 *a*, ultimate segment and trifid appendage; 16 *b*, part of the style and of a stylet enlarged × 3 diam. (Page 61.)



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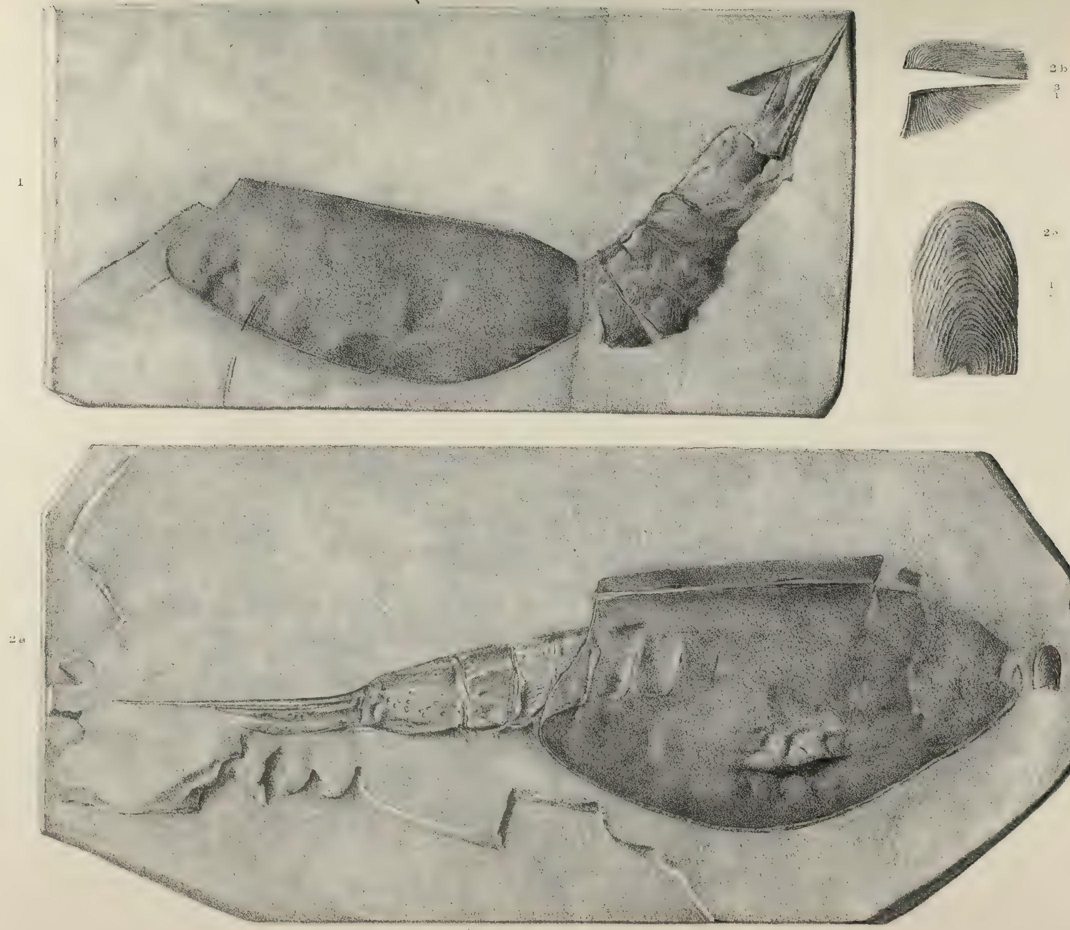
BRITISH FOSSIL PHYLLOPODA

PLATE XII.

(Figs. 1 and 2 *a* are of the natural size; figs. 2 *b* and 2 *c* are magnified.)

Figs. 1. *Ceratiocaris papilio*, Salter. Carapace, showing the right valve, with the abdomen and appendages shifted from behind to the front end, and turned upside down. British Mus. (Page 37.)

Figs. 2 *a*, 2 *b*, 2 *c*. *C. stygia*, Salter. A rather narrow example, perhaps a variety, or modified by pressure. 2 *a*, carapace with right valve outwards, and the abdomen and caudal appendages in place (a broken *rostrum* lies in front of the carapace); 2 *b*, the striæ converging at the postero-dorsal angles, enlarged 3 diam.; 2 *c*, the portion of *rostrum*, enlarged 4 diam. British Mus. (Page 42.)



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British Fossil Phyllopoda.

THE

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MDCCCLXXXVIII.

A MONOGRAPH

OF THE

BRITISH JURASSIC GASTEROPODA.

BY

WILFRID H. HUDLESTON, M.A., F.R.S., Sec.G.S.

PART I, No. 2.

GASTEROPODA OF THE INFERIOR OOLITE.

Pages 57—136; Plates I—VI.

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1888.

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Limestone can be obtained from the vicinity of Doynton, and also to the fact that there are several quarries on the plateau in the Great Oolite. The village of Little Sodbury is noteworthy as the place whence the Rev. Mr. Steinhauer supplied Sowerby with the types of *Trochus concavus*, *T. duplicatus*, and *T. dimidiatus* previous to the year 1818 ('Min. Conch.,' vol. 2, p. 180, pl. 181, figs. 3, 4, 5). As Little Sodbury itself is upon the Lias, these fossils must have been obtained from the Inferior Oolite quarries towards the top of the Cotteswold escarpment. The old parish pit in Mr. Steinhauer's time was situated at the very top of the road which leads straight up the hill, from the village, and is about half a mile south of the large quarry on Horton Hill.

Horton Hill Quarry.—This place is such a long distance from any convenient town, being about half way between Bath and Stroud, though somewhat nearer the latter, that it has always remained more or less a *terra incognita* to palæontologists. The exposure is an extremely interesting one, as affording us an insight into the development of the Inferior Oolite between the two points.

Commencing as usual at the base we find a somewhat variable thickness of poorly fossiliferous freestones. The top of this series is indurated and bored, affording evidence of a used surface, and thereby to a certain extent of uncomformity. The exact age of this series is not easy to determine, though it may be safely set down to some part of the *Murchisonæ*-zone, such as yields the greater part of the freestones or fine grained oolites of the Cotteswolds. Below Hawkesbury Upton not less than thirty feet of these beds are exposed.

The break between this and the rich shell-beds with Gasteropoda is most complete, lithologically and otherwise. There can be little doubt that these courses are the equivalents of the Upper Trigonia-grit of Stroud, &c. *T. costata* is very large and abundant, whilst the Clavellate species are less numerous. No Ammonites were found, but *Rhynch. spinosa* is not uncommon and often of considerable size. From this series, but especially from the lower course of stone, a considerable number of Gasteropods have been obtained. These fossils were associated with the large Conchifera in the ordinary way, but weathering for a long period had developed them to a considerable extent. Though fairly numerous, they are far less so than the Conchifera, &c. This horizon cannot fail to remind us of the one at Grove (see *Profile No.* 6), and there is one fossil here which has never yet been found by me, except in this instance, beyond No. 1 District, viz. *Cerithium ? contortum*, Desl., so characteristic of the *Parkinsoni*-beds of the south. Once more, then, we gather a rich harvest of Gasteropods on the horizon of P_1 of Burton-Bradstock Cliff. The absence of any representative of the *Humphriesianus*-zone at Horton Hill seems to be complete. Sometimes these beds occur in three courses.

It is extremely interesting to obtain above this a horizon defined by abundance

Profile No. 7.—Horton Hill Quarry.

(Section incomplete.)

				Fuller's Earth.[1]
UPPER DIVISION.	Parkinsoni-zone.		10′ 0″	White Oolitic Limestone in thin beds with few fossils. A few Brachiopoda.
		Clypeus-grit.	6′ 0″	An upper shelly series. Brachiopoda numerous and many large Conchifera.
			2′ 6″	A rubbly series, with many *Terebratula* near to *globata*, in nests: **Nerinæa Guisei.** Bands of hard stone.
		U. T. G.	3′ 2″	Rich shell-beds in 2 or 3 courses. Gasteropoda. *Rhynchonella spinosa, Trigoniæ.*
				Bored-bed.
LOWER DIVISION.	Murchisonæ-zone.		7′ 0″	Freestones with few fossils.
			28′ 8″ Total.	Bottom of quarry,

[1] In this and the succeeding Profiles it is not intended to imply that the Fuller's Earth is, in all cases, visible in the actual section.

of *Terebratula* near to *globata*, and especially by *Nerinæa Guisei*, which has never failed us since we entered No. 2 District. As we shall see presently, this certainly represents a portion of the *Clypeus*-grit. The upper shelly series, measured in the Profile as six feet, is in fact an accidental and extremely variable development, since towards the south end of the quarry the shells of this horizon have almost disappeared, whilst the highest beds of all represent a phase which is not uncommon in the Cotteswolds, but which would seem to possess but little palæontological interest. Altogether the Upper Ragstones are very fully developed in Horton Hill Quarry.

Travelling northwards we are able to obtain a nearly complete section of the entire Inferior Oolite in the ridge which forms a continuation of Symonds Hall Hill on the other side of Wootton-under-Edge. The Inferior Oolite limestones are now seen to attain a considerable thickness, and the Gloucestershire Cephalopoda-bed, or zone of *Am. radians*, is exceedingly well developed. Above it we perceive between thirty and forty feet of freestones (fine-grained oolite and broken-shell rock); towards the middle of this there is a slight unconformity in connection with a bed of *Nerinæa*. The top of the Freestone series is bored and hardened indicating unconformity to a marked extent. The whole of this Freestone series belongs in all probability to the *Murchisonæ*-zone. Above this we perceive a repetition of the Horton Hill sequence, viz. that a representative of the Upper Trigonia-grit rests directly on the freestones without any intervening Gryphite-grit. At this place, too, *Nerinæa Guisei* may be found in its usual position in the *Clypeus*-grit.

Nailsworth Hill.—The town is about six miles east-north-east of Wootton-under-Edge, and nearly twelve miles north-north-east of the exposure at Horton Hill previously described. Many of Lycett's specimens, now preserved in the Jermyn Street Museum, are labelled "I. O., Nailsworth Hill," though unfortunately the horizon is never indicated. As I have myself obtained a considerable number of Nerinæas from this locality, I append a complete profile of the Inferior Oolite of this district, mainly based upon the exposures on Scar Hill.

The lowest beds in this section partake of the Wootton and Frocester type. At the latter place Oppel[1] runs the Lias boundary (Lias-Grenze) between the *radians*- or *jurensis*-zone, and the *opalinus*- or *torulosus*-zone. A few Gasteropoda are obtained from this *opalinus*-zone in different parts of the Cotteswolds, but usually their condition is not favorable to accurate determination.

Considerable attention has been drawn to the small Gasteropods of the Lower Limestone, most of which, in addition to being extremely minute, are sadly rolled and defaced. *Cerithium* is the prevailing form. Mr. Witchell recently exhibited some of these at the Geological Society in illustration of a paper on the

[1] 'Juraformation,' p. 296.

Profile No. 8[1].—Nailsworth Hill and District.

(Section complete.)

			Fuller's Earth.
UPPER DIVISION.	Parkinsoni-zone.	3′ 0″	Oolite with few fossils.
		8′ 0″	*Clypeus*-grit series, with bed of *Terebratula globata* towards the top. **Nerinæa Guisei** below.
		4′ 0″	Upper Trigonia-grit.
		4′ 0″	Grit without gryphite.
			Bored-bed.
LOWER DIVISION.	Murchisonæ-zone.	35′ 0″	Thick-bedded Oolitic Freestones. *Nerinæa*-bed in upper part,[2] but no "Oolite marl" with *T. fimbria*.
		3′ 0″	Pea-grit, with several species of *Nerinæa*, especially at Longford's Mill.
		25′ 0″	Broken-shell Limestone and Oolite, with a few Gasteropods much rolled. (Lower Limestone of Mr. Witchell.)
	A	9′ 0″	Sandy, with a shell-bed towards the base. *Opalinus*-zone.
	B	5′ 0″	Gloucestershire Cephalopoda-bed, or zone of *Am. radians*.
		96′ 0″ Total.	Sands.

[1] Partly derived from observation, partly from other sources.

[2] Another bored-bed below the Nerinæas.

A *Opalinus*- or *torulosus*-zone. B *Radians*- or *jurensis*-zone. There is no intention here of entering into minute particulars as to the exact boundaries. The whole question of the *opalinus*-zone in the Cotteswolds is one of considerable obscurity. The Gasteropoda are scarce and in a bad state of preservation.

Lower Beds of the Inferior Oolite.[1] A list of those determined is given at p. 270. It was likewise, I believe, the opinion of Prof. R. Tate that several undescribed species of Gasteropods (minute) were to be found in this series. Hitherto I confess that my own researches have not been very successful. Moreover, if Mr. Witchell's specimens are to be taken as a sample, there are not many people who would venture to describe them. Whilst on the subject of these Micromorphs I may observe that the Pea-grit of Leckhampton, Crickley, &c., contains several small Gasteropods, many of which appear to be merely the young of well-known species. As such extremely small shells would require different artistic treatment from the bulk of the Gasteropoda to be described in this memoir, it might be convenient to place them in a separate category by way of supplement; that is to say, if they should prove to be of sufficient importance.

The Pea-grit is exposed on the flank of the hill, and on this horizon the earliest[2] Nerinæas in the Cotteswolds may be noticed. The same bed is well shown in a roadside cutting near Longford's mill, and has there afforded several species of *Nerinæa* usually distinct from those of the Oolite Marl. High up in the freestone series is another bed with *Nerinæa*, which may probably represent the extremely rich beds in connection with the Oolite Marl on the other side of Stroud. The third Nerinæan horizon is that in the *Clypeus*-grit, which we have now traced continuously through so many exposures.

The *Clypeus*-grit is characterised by *Nerinæa Guisei*, Witc.
The Freestones, Oolite Marl, &c., by *Nerinæa Cotteswoldiæ*, Lyc.
— *gracilis*, Lyc.
The Pea-grit by *Nerinæa producta*, Witc.
— *pisolitica*, Witc.

These three Nerinæan horizons, in the Pea-grit, the Oolite Marl, and the *Clypeus*-grit, respectively, have also yielded the bulk of the somewhat scanty collections of Gasteropoda which have been obtained from the more classical districts of the Cotteswolds. On the other hand, the Upper Trigonia-grit and the Gryphite-grit, well stored as they are with other fossils, seem to be deficient in this respect. Hence the Ragstones, though far more fossiliferous as a whole than the beds of the *Murchisonæ*-zone in this neighbourhood, contain fewer Gasteropoda.

Rodborough Common, about three miles north of Nailsworth Hill. This again is classic ground, many both of Dr. Lycett's and Mr. Witchell's specimens coming from here. I subjoin a profile, showing the upper or Ragstone-beds in some detail.

The Upper White Oolite is the bed we have generally met with hitherto in the Cotteswold Hills, usually forming the top of the Inferior Oolite. The next three

[1] 'Quart. Journ. Geol. Soc.,' vol. xlii (1886), p. 264, *et seq.*

[2] The Lower Limestone has hitherto yielded only imperfect fragments of *Nerinæa.*

Profile No. 9.—Rodborough Common.

(Section incomplete.)

				Fuller's Earth.
UPPER DIVISION.	Parkinsoni-zone.		5′ 0″	Upper White Oolite, with few fossils.
		Clypeus-grit.	2′ 6″	*Terebratula globata* very abundant.
			3′ 0″	Beds generally fossiliferous. **Nerinæa Guisei** and other Gasteropods.
			4′ 0″	Unfossiliferous earthy Limestones.
			3′ 0″	**Upper Coral-bed.**
			4′ 0″	Upper Trigonia-grit.
			2′ 0″	Gryphite-grit: Conchifera abundant.
LOWER DIVISION.	Murchisonæ-zone.			Bored-bed.
			20′ 0″	Upper Freestones.
			43′ 6″ Total.	Oolite Marl and Lower Freestones.

subdivisions may be taken to represent the *Clypeus*-grit. Here, as elsewhere, the great mass of *T. globata* occurs just above the *Guisei*-bed. This series has afforded Mr. Witchell several species of Gasteropoda, including the *Nerinœa* so often mentioned and some others. As a horizon therefore it is deserving of some notice. Mr. Witchell's types of *N. Guisei*, &c., are, I believe, from this very bed on Rodborough Common.

The next point worthy of notice is the Upper Coral-bed, which according to Mr. Witchell has its southward limits hereabouts. The Upper Trigonia-grit of this section calls for no special comment. This is the bed that we have seen continuously from the neighbourhood of Little Sodbury (Horton Hill). It appears to contain but few Gasteropoda here; at least I find no great number in Mr. Witchell's collection from this horizon. For all that, I have very little doubt of its being the representative of the rich shell-beds which, further south, have yielded such an abundance of Gasteropoda towards the base of the *Parkinsoni*-zone. There are also but few Gasteropoda from the Gryphite-grit, and consequently we need not take much trouble to discuss its geological position. Rodborough Common is about the last exposure where it contains the characteristic Gryphite, whilst further south (Wootton-under-Edge, Horton Hill, &c.) the beds of the *Parkinsoni*-zone rest directly on the Cotteswold Freestones. The Gryphite-grit has generally been regarded as belonging to the *Humphriesianus*-zone, but I leave this question to be discussed elsewhere. The entire Ragstone series, or Upper Division of the Inferior Oolite, on Rodborough Common measures about 23 feet, whilst the section on Stroud Hill, only just across the valley, has already increased to 37 feet (*teste* Witchell) partly owing to the expansion of the Gryphite-grit.

Stroud, Swift's Hill, and Longridge.—These are all on the north side of the deep valley which commences at Stonehouse; they may be taken together as constituting one section, so to say, of the Cotteswold District. *Swift's Hill Quarry* is about one and three quarter miles north-east of Stroud station near *Knapp Farm*. There is a fault in this quarry, which is mainly in the Freestone series. The *Nerinœa*-bed occurs several feet below the soft Oolite Marl. It forms part of two blocks, and the Nerinæas occupy a vertical space of about 2 feet 6 inches. The lower bed is a mixture of chalky stuff and oolite, and this is the best for fossils; sections of *Nerinœa* are extremely numerous. The quarry at *Longridge* is on very high ground two miles north of Swift's Hill, and about one mile east of the small town of Painswick. The quarry is in such a muddle that no section can be obtained; but the horizon whence the bulk of the fossils are obtained is probably a little below the Oolite Marl. A very fine series of Nerinæas have been procured from this place lately both by Mr. Witchell and myself. Taking *Stroud Hill* as the representative section of the region immediately north of the great valley, we obtain the following sequence. For further details I would refer to Witchell's Geology of Stroud, p. 5.

Profile No. 10.—Country more immediately north of Stroud Valley generalised.

(Section incomplete.)

			Fuller's Earth.
UPPER DIVISION.		37′ 0″	Ragstones, including Gryphite-grit, 12 ft. } Divisions not specified here.
LOWER DIVISION.	Murchisonæ-zone.		Bored-bed.
		10′ 0″	Upper Freestones.[1]
		6′ 0″	Oolite Marl, with *T. fimbria.* Middle Coral-bed. Gasteropoda, including *Nerinæa.*
		70′ 0″	*Nerinæa*-bed of Swift's Hill in the upper part. Main Freestones.
		3′ 0	Pea-grit, with *Nerinæa.* Corals.
		126′ 0″ Total.	Lower Limestone of Inferior Oolite.

[1] There are indications of a *Nerinæa*-bed in the Upper Freestones, which may be on the horizon of the bed, *p*, near Birdlip (see *postea*, p. 66). On the whole there are three distinct beds containing *Nerinæa* in the *Marl and Freestone Series*, though these beds cannot be made out at every point between Stroud and Cheltenham. These three beds constitute the Middle or Second Nerinæan horizon.

We observe here that the "Oolite Marl" has now a definite lithological development. Judging from the collections made by Lycett and Witchell in this district, the "Oolite Marl" has been the principal source of the Gasteropoda, few and scattered though they be. The fossils are preserved in a good spathic condition, and often beautifully white; but as the matrix is somewhat unkind, a great amount of scraping has in many cases materially injured the ornamentation. Hence these fossils, though undoubtedly the best afforded by the Inferior Oolite of the Cotteswolds, compare unfavorably with those of Dorsetshire. In consequence of this circumstance their correlation with the Dorsetshire fossils is by no means so satisfactory as could be wished. The Oolite Marl and part of the Freestones, probably, constitute one palæontological horizon, which must be referred to the upper part of the *Murchisonæ*-zone. For practical purposes, then, we may divide the *Murchisonæ*-zone of this part of the Cotteswolds into an Upper, or Oolite Marl horizon, and into a Lower, or Pea-grit horizon, without attempting to draw a strict divisional line between the two. The increasing thickness of the Inferior Oolite will be observed; we started at Burton Bradstock with about 12 feet of limestone, and here we have 126 feet without including the lowest beds.

Birdlip, Crickley Hill, Leckhampton Hill.—This group must be considered together and somewhat briefly. Birdlip is about four miles north-east by north of the *Nerinæa*-quarry at Longridge, and the main quarries on Leckhampton Hill are about three miles farther. Crickley Hill lies between, rather nearer to Birdlip. The development of the Ragstones continues to differ somewhat from that obtaining south; and hitherto we have failed to find the *Guisei*-bed in any exposure north of the Stroud valley. A deposit, known as the Lower Trigonia-grit, underlying the Gryphite-grit, contains a considerable number of casts of Gasteropoda. We must turn to the lower division of the Inferior Oolite—to the Freestones, Oolite Marl, and Pea-grit. Not that these are by any means rich in Gasteropoda. A most diligent search is necessary, and even then the specimens are often very small, little better than micromorphs. Mr. P. B. Brodie for many years collected from the Freestones of this neighbourhood, and without his aid I should know very little of their contents. Many extremely small Gasteropods have also been obtained by breaking open *Terebratulæ*, *Pholadomyæ*, &c., obtained between Birdlip and Crickley. Mr. George, of Northampton, has been kind enough to supply me with some of these micromorphs, and my own collector, Mr. Bloomfield, has procured several, mostly from the Pea-grit. But there is no notable assemblage of small Univalves between the Pea-grit and the Sands. A few are found in a thick-bedded stone, which probably corresponds to the horizon in the Lower Limestone at Stroud, already mentioned.

The lines where *Nerinæa* occurs in the Freestone series of this vicinity are somewhat obscure in consequence of the condition of the specimens. But some-

thing like the following sequence can be made out, commencing from the top. In a shallow quarry north of Birdlip is a *Nerinæa*-bed (*p*), immediately beneath the Ragstone. In the Birdlip Hill section *Nerinæa* occurs in the Oolite Marl (*q*), and the same may be seen in the Oolite Marl of Leckhampton Hill. Again, both at Leckhampton and Birdlip, a third *Nerinæa*-bed (*r*) occurs some twelve feet below the Oolite Marl. When it is borne in mind that each of these beds represents, usually, a slight line of erosion, and that probably other Gasteropoda have been procured from them, the fixing of these lines in the Freestone series becomes a point of some interest. The prevailing species on each of these three lines, or subhorizons, is somewhat different. The bed *r*, towards the top of the Lower Freestones, is distinguished by *N. Cotteswoldiæ*. These three beds belong to the Oolite Marl, or middle Nerinæan-zone of the Cotteswolds, including in this term the bulk of the Freestones.

We must now consider the lower or Pea-grit Nerinæan-zone, as developed in Crickley Hill.

The principal object of the Profile of Crickley Hill (p. 67) is to exhibit the relations of the Pea-grit to the beds above and below. There is no difficulty about the horizon, since *Am. Murchisonæ* is not uncommon in the Pea-grit. The "semipisolite," or equivalent of the Lower Limestone of Mr. Witchell, is very barren hunting ground. The shell-beds towards the base of the section have not yielded any notable quantity of Gasteropoda, but there are symptoms of a fauna similar to that at Drympton on the borders of Dorset and Somerset.

The really important bed in this Profile is the one containing long narrow forms of *Nerinæa*, of which sections are fairly numerous, and many smallish but rather well-preserved Gasteropoda; of these there are a few scattered throughout the Pea-grit and Freestones generally. Two species of *Nerita* are to be found in this bed. At the east end of the quarry face the line of the *Nerinæa*-bed is occupied by a small coral reef—the lower reef of the Cotteswolds. The great expansion of the Pea-grit from about three feet at Nailsworth and Stroud to upwards of thirty feet here is remarkable: in fact we are now entering on the region of maximum sedimentation of the Cotteswolds, and it is a matter of considerable interest for those who have traced the Inferior Oolite from its first appearance in the cliffs of the English Channel, to reflect that a subordinate series in the *Murchisonæ*-zone at Crickley is nearly three times thicker than the entire Inferior Oolite throughout some of the most fossiliferous exposures in Dorsetshire.

I will not dwell any further upon the Inferior Oolite as exhibited in the grand semicircular escarpment from Leckhampton to Cleeve and farther north, but will conclude this notice of its development in the Cotteswolds with a brief account

[1] This is probably the same as the Swift's Hill bed (see Profile, p. 64).

Profile No. 11.—Crickley Hill.

(Section incomplete.)

				Lower *Freestones* continued.
LOWER DIVISION.	Murchisonæ-zone.		15′ 0″	White shivery oolites, constituting the base of the *Freestones.* Junction bed harder and darker.
		Pea-grit 33 ft. 6 in.	6′ 6″	Coarse pisolite, with some fossils.
			4′ 0″	*Nerinæa* and other **Gasteropoda** { in the Pea-grit. **Lower Coral-bed.**
			23′ 0″	Main mass of the Pea-grit in thick beds of coarse pisolite. *Echini*, *Pentacrinus*, and a few Gasteropoda.
			15′ 6″	Semi-pisolite, with very few fossils.
	Opalinus-zone.		8′ 6″	Two rich shell-beds, with a few[1] Gasteropoda.
			3′ 0″	Continuation of the semi-pisolite.
			75′ 6″ Total.	No further exposure.

[1] An Ammonite related to *A. corrugatus* and *Rhynch. subdecorata*, juv., occur in this bed, which represents either a very low part of the *Murchisonæ*-zone, or, what is about the same thing, the so-called *Opalinus*-zone.

of the beds which have yielded Gasteropoda in the country between Cheltenham and Bourton, more especially near Notgrove Station and Aston Farm.

NOTGROVE, ASTON.—The Gasteropoda obtained from this neighbourhood are from two distinct horizons, viz. the Oolite Marl and the Trigonia-grit. The annexed profile is not intended to grapple either with the stratigraphy or the actual development of the Inferior Oolite as displayed in the interesting cuttings and quarries between Notgrove and Bourton, but simply to show the relative positions of the beds containing Gasteropoda.

There is a very fine development of the Oolite Marl at Notgrove Station, indeed I am not aware of a finer one anywhere. The lowest beds visible swarm with Brachiopoda, *T. fimbria*, *T. curvifrons*, *Wald. Leckenbyi*, *Rhynch. Lycetti*, &c., The lowest hard bed associated with these contains an immense *Pseudomelania*, which at present I cannot differentiate from "*Chemnitzia*" *simplex*, M. and L. Then comes another soft bed swarming with Brachiopoda, and then another hard bed full of immense specimens of *Natica cincta*, nearly all as casts. This latter is, above all others, the "Leitfossil" of the Oolite Marl, and may be traced on the same horizon through the Lincolnshire Limestone into the Whitwell Oolite of Yorkshire, whence came the specimen figured by Phillips. It is interesting to find that both these great fossils are recorded by Mr. Walford from Combe Hill, an outlier of Inferior Oolite some four and twenty miles to the east-north-east of Notgrove Station, and close to the Cherwell Valley; but there the characteristic Brachiopods are scarce.

The upward sequence from this very fine development of the Oolite Marl is not precisely clear. We should naturally expect the Upper Freestones, but in the cutting near Aston Farm, whence the bulk of the Gasteropoda marked "Aston" are derived, a series of imperfect Freestones, associated with two beds of Gryphites, immediately underlies the Ragstones. Whatever these beds represent it is clear that the Gasteropoda found in this cutting and the neighbouring quarries lie at the base of the *Parkinsoni*-zone, or, it may be, in a thin band which is a little lower, since they are mostly found at the base. On the whole, however, I incline to the belief that they belong to the lower part of the *Parkinsoni*-zone, an horizon we have found so rich in Gasteropoda throughout both the Dorset and Cotteswold districts. Both in development and state of preservation they are far inferior to fossils from more favoured localities. A smooth *Cerithium* is one of the most abundant and characteristic Gasteropods.

Résumé of the Cotteswold Hills.

Considering the great development of the Inferior Oolite in this range the palæontological results on the whole are very inferior to those of No. 1 district,

Profile No. 12.—NOTGROVE—ASTON, generalised.

(Section incomplete.)

				Fuller's Earth.
UPPER DIVISION.	Parkinsoni-zone.		11′ 0″	Dark brown sandy beds.
UPPER DIVISION.	Parkinsoni-zone.		34′ 0″	*Clypeus*-grit series.
UPPER DIVISION.	Parkinsoni-zone.		3′ 0″	Trigonia-grit, with *Am. Parkinsoni.* **Gasteropoda at base.**
				Bored-bed.
LOWER DIVISION.	?[1]		24′ 0″	Bastard Freestones associated with two beds of Gryphites, Keeled Ammonites, Ragstones, and yellow micaceous sands.
LOWER DIVISION.	Murchisonæ-zone.		14′ 0″	[2] Freestones principally observed at Notgrove Station.
LOWER DIVISION.	Murchisonæ-zone.	Oolite Marl.	5′ 0″	Soft marly rock, with blueish argillaceous patches. Fossils scarce.
LOWER DIVISION.	Murchisonæ-zone.	Oolite Marl.	2′ 6″	Hard stone, with *Natica cincta.*
LOWER DIVISION.	Murchisonæ-zone.	Oolite Marl.	5′ 0″	Soft Marl. Brachiopoda numerous.
LOWER DIVISION.	Murchisonæ-zone.	Oolite Marl.	2′ 0″	Hard stone, with large *Pseudomelania.*
LOWER DIVISION.	Murchisonæ-zone.	Oolite Marl.	2′ 6″	Soft. Brachiopoda very numerous.
			103′ 0″ Total.	Continuation of the *Murchisonæ*-zone below the Railway.

[1] Mr. S. S. Buckman is of opinion that the beds associated with Gryphites are on the horizon of the Gryphite-grit of Leckhampton and Stroud, which for him represents the *Sowerbyi*-zone of Dorset.

[2] This is the horizon of the Bored Bed of the preceding profiles. The Freestone series here also is slightly bored on the top; but in this section the *main unconformity* is upon a higher horizon than that of Stroud, Horton Hill, &c.

more especially in Gasteropoda. When we bear in mind that some of the best collectors, and the most noted palæontologists, have been connected with the Cotteswolds for years, it must be clear that this inferiority cannot be due to want of research. In fact the country from Wootton-under-Edge to Cleeve Cloud is, above all others, the classic ground of the Inferior Oolite. It is true that in some portions of the range, and on some horizons, a considerable number of casts and badly preserved specimens of Gasteropoda may reward the labours of the collector. But how rare are really good fossils? If it were not for the Nerinæas, whose critical points are, perhaps, more internal than external, the show would be but a poor one, when we reflect on the many years that these beds have been under contribution.

There is another point, too, of some significance. Apart from mere specific names, such as help to make up a percentage comparison, there can be no doubt that the Gasteropod Fauna of the Great Oolite, as developed at Minchinhampton, has far more resemblance to that of the Inferior Oolite, which underlies it, than it has to the Gasteropod Fauna of the Inferior Oolite in the Dorset District. Greater similarity of facies may in parts account for this, but is there nothing due to the score of locality? Such questions are interesting, and, if taken up and worked out by younger palæontologists, may some day lead to conclusions of importance.

Lastly, it would seem that the Ammonite-zones are not quite so regular and well defined in the Cotteswolds as they are in Dorsetshire. When the question comes to be worked out, this may not prove to be the case; nor is it my business in the present instance to investigate it. But when we see such an anomalous assemblage of Ammonites as occurs for instance in the Gryphite-grit (*teste* Mr. Witchell's collection), we naturally wonder how this series can be made to fit in with the Dorsetshire sequence.

Remainder of the Cotteswold District.

East of the Vale of Moreton there is a mass of high ground constituting a sort of repetition of the Cotteswold Hills. This region extends as far as the Valley of the Cherwell. The Inferior Oolite is variously developed, but on the whole the *Clypeus*-grit is the main representative, at least near Chipping-Norton. The Gasteropoda in these beds of Inferior Oolite age are not sufficiently numerous or important to warrant many details being given here. The most important section is on the new railway near Hook Norton, where on both sides of a tunnel a more or less complete sequence of the Inferior Oolite may be seen. This has been fully described by Mr. Walford ('Quart. Journ. Geol. Soc.,' 1883, p. 224).

Hook Norton.—Though the Inferior Oolite is now verging towards the region where it undergoes further modification and a partial eclipse, before assuming

its East Midland character, the section at Hook Norton, read by the light of Mr. Walford's experience, is both interesting and instructive. Between the Upper Lias Clay and the Great Oolite are 31 feet of beds. These are divided into five groups. The *lowest group*, 4 feet 9 inches, is a sandy blue hearted limestone with corals. It has yielded *Rhynchonella cynocephala* and some few Gasteropoda characteristic of a low horizon. Since it is by no means easy to separate the *Opalinus*- from the *Murchisonæ*-zone, this group may be taken as representing the zone or zones usually characterised by those two Ammonites. The *second group*, 10 inches thick, contains an Ammonite-bed; the species being one of those smooth, flattish forms, similar to the prevailing types in the *concavus*- or so-called *Sowerbyi*-beds of Bradford Abbas. *Terebratula perovalis* likewise is quoted from here. Both the first and second group belong to the Lower Division of the Inferior Oolite. Next comes the usual hiatus, and then the *third group*, 2 feet 10 inches, has a shell-bed towards the top with undoubted fossils of the *Parkinsoni*-zone; and in this shell-bed are several species of GASTEROPODA. If this group represents the Trigonia-grit, the Gasteropoda lie at the top, instead of at the bottom as in the Aston cutting. The *fourth* and *fifth groups* of this section call for no notice here. They are bulky and for the most part devoid of Mollusca, and serve to show the changeable nature of the uppermost beds of the Inferior Oolite hereabouts.

DETAILS OF THE EAST MIDLAND DISTRICT (No. 3).

The first fossiliferous beds of Inferior Oolite age in this district which attract our attention are those at Blisworth and round the town of Northampton (DUSTON, &c.), which were regarded by Mr. Sharp as in the zones of *Am. opalinus* and *Am. Murchisonæ.* I see no reason to doubt Mr. Sharp's determination, the more so as there is a certain degree of resemblance between the Yorkshire Dogger and the *Northampton Sand.* Cephalopoda are not plentiful, but the Conchifera are large, especially *Lima*, and fairly numerous. The Gasteropoda are not particularly abundant, nor in a satisfactory condition for determination, occurring principally as impressions in the ironstone. Hence they are not very nice cabinet specimens. It is not probable, therefore, that many, if indeed any, of these specimens will be selected for figuring; but they will at all times be useful for correlation in those cases where the species can be made out with certainty. The best specimens are in the Sharp collection at the British Museum. At present I am informed by Mr. George and Mr. Beeby Thompson, that it is not easy to obtain many specimens of interest from these beds.

But the main feature of Inferior Oolite age in the East Midland District is the *Lincolnshire Limestone.* The chief characteristics of this important series are

given in 'Judd's Geology of Rutland,' and more recently in another Survey Memoir by Messrs. Jukes-Browne and Dalton. So extensive is this subject, that I may well be excused for not entering into particulars in an "Introduction to the Inferior Oolite Gasteropoda." As regards the position of the Lincolnshire Limestone in the geological scale, it has generally been referred to the *Sowerbyi-* subzone. But I am disposed to think that the greater portion of it belongs to the upper part of the *Murchisonæ*-zone. This would bring it on the level of the Oolite Marl of the Cotteswolds, simply as regards geological time. I think that there can be little doubt, from the abundance of *Nerinæa Cotteswoldiæ* in the compact limestones of so many localities, that such beds are on the horizon of the Oolite Marl, or just a little below, whilst the abundance of casts of *Natica cincta* (*Leckhamptonensis*) seem to point to the Oolite Marl itself. But it is apparently above these beds where we find that finely oolitic and broken shell-rock which swarms—though only at rare intervals—with Gasteropoda. Unfortunately they are much rolled, but now and then some really good specimens are obtained. Though the prevailing forms are decidedly small in these beds, yet some shells, especially those of *Nerinæa*, attain a considerable size.

By far the richest exposure of this class of beds is at Great Weldon, four and a half miles south-south-east of Rockingham, in Northamptonshire. As a section it is of no value, being a mere roadside opening near the village, about 8 feet in depth. The uppermost 4 feet consist of a shivery or platy kind of rock, with numerous small Oysters on the bedding planes. The lower half is a comminuted shell and oolite rock, and it is on the top of this that the richest accumulation of small Gasteropods may be noticed. A few hundred weights of well selected stuff will afford employment to the fossil hunter during many a winter's day. Innumerable small *Cerithia* of the *limæforma* group, some of them identical with *C. Beanii* of the Yorkshire Beds, are probably the most characteristic fossils. *Monodonta lævigata*, usually the typical form, but rather smaller than Dundry specimens, is on every block, and small species of *Trochus*, &c., are very numerous. The largest shells I have met with are the so-called "Phasianellas," which seem to occupy the place of *Natica*, here almost entirely unrepresented. The curious shell *Cloughtonia cincta* occurs here, and also at Ponton, but is rare. This constitutes another link with the Yorkshire Beds. I am not aware of its ever having been detected further south.

Another exposure is at Wansford, about eight miles west of Peterborough. This was more famous in former days, and is probably the locality "near Peterborough" of the Sharp collection. The Northampton collectors have obtained some good things from here, but the section is for the most part grass grown, and fine fossils are scarce.

The next best place is the railway cutting at Great Ponton. The depth of the cutting is about 20 feet. The beds which contain the Gasteropoda are very limited

in extent, and owing to the confusion and crushing of the rock, it is not easy to trace their relation to the *Terebratula*-beds, which are seen farther up the line (towards the south). It is by no means easy to say whether these beds are on precisely the same horizon as those at Weldon. The general character is the same, but each has its peculiarity. At Weldon, for instance, *Monodonta lævigata* swarms; here it seems almost absent. The species of *Nerinæa* too seem to differ, but where all, or nearly all, are so much rolled, the question of the Nerinæas of the Lincolnshire Limestone is not one calculated to give much peace of mind to a palæontologist.[1]

Barnack is another place which has yielded in former times a considerable number of these small Gasteropoda. At present what few fossils can be obtained are picked up on refuse heaps. There are many other quarries in Northamptonshire, Rutland, and South Lincolnshire which have yielded here and there a few good fossils. Some of these quarries are undoubtedly on the horizon of the Oolite Marl; as regards the others I have no evidence. One thing must strike the most casual observer, and that is the extraordinary difference between the Gasteropod Fauna of Dorsetshire, and of the Lincolnshire Limestone. Some forms, it is true, are merely micromorphs of species occurring elsewhere; but even granting that, the contrasts are enormous.

North of Grantham I have no knowledge of the Lincolnshire Limestone, or of its fossils, with the exception of a very few specimens now in the Jermyn Street Museum. Should I subsequently discover any notable quantity of Gasteropoda in the Inferior Oolite of this region, it may be necessary to deal with the subject by way of postscript.

Failing other evidence, we must regard the Northampton Sand, the Collyweston Slate, and, perhaps, the whole of the Lincolnshire Limestone, as belonging to the Lower Division of the Inferior Oolite.

[1] The cuttings known as Little and Great Ponton, on the Great Northern Railway, south of Grantham, were described by Prof. Morris ('Quart. Journ. Geol. Soc.,' ix, 324) with considerable detail, and these descriptions are quoted in Messrs. Jukes-Browne and Dalton's 'Geology of S.-W. Lincolnshire.' These authors consider the thickness of the Lincolnshire Limestone in South Lincolnshire to be fully 100 feet. They regard it as a lenticular mass between the Lower and Upper Estuarine, and further state that there is no constancy in the occurrence of the "coralline facies" as distinct from the "shelly facies;" since either may occur on any horizon. Mr. Brodie's observation is quoted that the more marly layers are particularly rich in corals, and recall the facies of the Oolite Marl at Crickley.

Details of the Yorkshire Basin (No. 4).

The beds of Inferior Oolite age in this region are completely separated from those to the south; and their present outcrop is nearly at right angles to that of the Cave Oolite and Lincolnshire Limestone. Although these arrangements are probably mere accidents of stratigraphy, the result is the complete isolation of all the Jurassic rocks of the basin of North-east Yorkshire. Since this is the case, there can be no harm in reversing our previous practice of proceeding from the south northwards, and in at once taking into consideration the important development at Blue Wyke. The following is in the main an extract from 'Contributions to the Palæontology of the Yorkshire Oolites,'[1] describing the marine horizons or zones of the Inferior Oolite, based chiefly upon the coast sections.

1. *First or lowest zone.*—This is known as the Dogger. Including the grey sands (*Lingula*-beds), the yellow sands, and the Dogger proper, a thickness of 80 feet may be assigned to the group, where most fully developed, as at Peak (Blue Wyke). The remains of Gasteropoda are almost wholly confined to a shell-bed 18 inches thick, which occurs about eight feet below the top of the series at Peak, but nowhere else in Yorkshire. The matrix is very characteristic. The substance of the shells has been largely replaced by spathic iron, whilst their exterior is lined with a thin skin of dark brown oxide. From the abundance of *Nerinæa cingenda* this band has been named the *Nerinæa*-bed, which is probably somewhere about the horizon of the Pea-grit of the Cotteswolds, though not improbably it contains species of a somewhat lower horizon. The Dogger in its totality may be placed in the *Opalinus*-zone and lowest part of the *Murchisonæ*-zone, and there can be little doubt that *Am. striatulus* (*radians*) crosses the boundary into the lower beds. Some 300 feet of "estuarine" sands and shales, with at best only irregular traces of marine shells, succeed the Dogger, and then we arrive at—

2. *The second zone*, known as the Millepore-bed, which is best seen on the north horn of Cloughton Wyke at Sycarham, where the thickness may be about 12 feet. This is also a kind of sandy ironstone, but more gritty and calcareous than the Dogger. The Gasteropoda are mostly limited to one bed, whilst Conchifera are abundant throughout. Some portions of the matrix contain more carbonate of iron than of lime, and there is just sufficient iron peroxidized to impart a reddish-brown tint to the mass, which is much flecked by a white substance allied to kaolin. This peculiarity is less noticeable in the bed where the univalves are mostly found. The Millepore-bed is well developed south of Scarborough, where it becomes thicker. It forms an important scar in Gristhorpe Bay. In the

[1] 'Geol. Mag.,' dec. ii, vol. ix (1882), p. 148.

Profile No. 13.—The Yorkshire Coast.

(Generalised Section, possibly complete.)

Division	Zone	Series	Bed	Thickness		Description
						Upper Shale and Sandstone.
UPPER DIVISION.	Humphriesianus-zone.	Scarborough Limestone.		54′	23′	Shales with *Avicula braamburiensis*.
					13′	Upper Grey Limestone, with *Am. Humphriesianus*, &c., at White Nab.
					18′	Lower Grey Limestone and Iron Scar of Pickering Cliff. Gasteropoda.
LOWER DIVISION.	Murchisonæ- and ? Sowerbyi-zone.	Millepore.		100′		Middle Shale and Sandstone, with Coal and Plant-beds.
			Millepore.	12′[1]		Millepore-bed { A few small Gasteropoda.
				300′		Lower Shale and Sandstone. (*Pholadomya*-bed occurs in this series.)
			Dogger.	84′	33′	*Nerinæa*-bed, 18 inches. Gasteropoda. Brown Dogger.
	Opalinus-zone.				25′	Yellow Sands below Dogger.
					26′	Grey Sands below Dogger.
				550′ Total.		*Striatulus*- or *jurensis*-beds.

[1] Represented in the interior by the Whitwell Oolite, which yields *Natica cincta*, Phil.

obscure problem presented by the Inferior Oolite Gasteropoda in the Cotteswolds. Nor should I, when on the subject of Cotteswold fossils, forget the kindness of the Rev. P. B. Brodie. This veteran geologist, years ago, made it his business to collect specimens principally from the Freestones of Leckhampton and the neighbourhood. These he most generously permits me to examine and to retain for figuring when necessary. I have long been under obligations to Mr. Walford, of Banbury, whose intimate acquaintance with the Inferior Oolite of North Oxfordshire has been proved more than once in the pages of the 'Quarterly Journal of the Geological Society.' Nor must I forget to thank Mr. George and Mr. Beeby Thompson, of Northampton, for assistance and information in their own district.

The principal museums, whose collections have been consulted, are—the British Museum, the Museum of Practical Geology in Jermyn Street, the Bristol Museum, the Woodwardian Museum, and, for Yorkshire fossils only, the York Museum. Nothing could exceed the kindness and consideration of the officers in charge, and I tender them my heartfelt thanks.

List of some of the Works consulted.

Published previous to 1840.

1812–29 Sowerby. The Mineral Conchology of Great Britain. 6 vols.
1822 Young and Bird. A Geological Survey of the Yorkshire Coast.
1829, '35 Phillips. Geology of the Yorkshire Coast.
1831 Deshayes. Description des Coquilles caracteristiques des Terrains.
1836 Voltz. On the genus *Nerinœa* in the *Neues Jahrbuch.*
— Roemer. Die Versteinerungen des Nord-deutchen Oolithen-Gebirges. *Hanover.*
1839 —— Ein Nachtrag.
1837 Koch and Dunker. Beiträge des Nord-deutchen Oolithgebildes. *Brunswick.*
— Bronn. Lethæa Geognostica. *Stuttgart.*[1]
1835–1845. Deshayes. Lamarck's *Hist. Nat. des Anim. sans vertèbres.* 3rd Ed.

Between 1840 *and* 1849.

1842 Eudes Deslongchamps. Several memoirs on Jurassic Gasteropoda. *Mém. Soc. Linn. Norm.*, vol. vii.
1843 D'Archiac. Formation oölithique de l'Aisne. *Mém. Soc. Géol. de France.*

[1] Second edition published in 1856. This I have not seen.

1842–1844 Goldfuss. Petrifacta Germaniæ. 3rd part.
1845 Buckman, J. In Murchison's Geology of Cheltenham.
1848 Eudes Deslongchamps. Mémoire sur les Pleurotomaires, &c. *Mém. Soc. Linn. Norm.*, vol. viii.
1849 Bronn. Index Palæontologicus.

Between 1850 *and* 1859.

1850 D'Orbigny. *Prodrome de Paléontologie*, vol. i.
— Sharpe, D. On the genus *Nerinæa*. *Quart. Journ. Geol. Soc.*, vol. vi.
— Lycett. *Ann. Nat. Hist.*, vol. vi.
1851, '53, '55 Morris and Lycett. Mollusca of the Great Oolite. Palæontographical Society. Includes the so-called "Great Oolite" of Yorkshire.
1852 Buvignier. Statistique, géologique, &c., du département de la Meuse.
— D'Orbigny. *Paléontologie Française, Terrain Jurassique*, vol. ii.
1853 Morris. Lincolnshire Oolites, with Descriptions of some New Species of Mollusca by Lycett. *Quart. Journ. Geol. Soc.* vol. ix.
— *Proc. Cotteswold Naturalists' Field Club*, vol. i.
— Brodie. Geology of Grantham.
— Lycett. Fossil Shells from the Inferior Oolite of Gloucestershire.
— Wright. Strombidæ of the Oolites.
1854 Morris. Catalogue of British Fossils, 2nd Ed.
1855 Piette. Étages Inférieurs Jurassiques des Ardennes, &c. *Bull. Soc. Géol. de France*, 2me série, vol. xii.
1856 —— Notice sur les coquilles ailées trouvées dans la G. O. de l'Aisne, &c. *Op. cit.*, vol. xiii.
— —— Notice sur les grès d'Aiglemont et de Rimogne. *Op. cit.* vol. xiii.
— —— Sur les coquilles voisins des Purpurines, &c. *Op. cit.* vol. xiii.
1857 —— Descriptions des *Cerithium* enfouis dans les dépôts Bathoniens, &c. *Op. cit.*, vol. xiv.
1851–1856 Woodward, S. P. Manual of the Mollusca.
1856–1858 Oppel. Die Juraformation.
1857 Lycett. Handbook to the Cotteswold Hills.
— Hull. Geology of the Country round Cheltenham. *Mem. Geol. Survey.*
1858 Quenstedt. Der Jura.
1859 Chenu. Manuel de Conchyliologie.
— Wright. On the Subdivisions of the Inferior Oolite in the South of England compared, &c. *Quart. Journ. Geol. Soc.*, vol. xvi.

Between 1860 *and* 1869.

1860 Hébert and Deslongchamps. Mém. sur les Fossiles de Montreuil Bellay. *Bull. Soc. Linn. Norm.*, vol. v.

1860 E. and E. Deslongchamps. Note sur le genus *Eucyclus*, &c. *Vol. cit.*

1860–1861 Piette. Sur un nouveau genre des Gasteropodes. *Bull. Soc. Géol. de France*, 2me série, vol. xviii, pp. 14—16.

1861 Stoliczka. Gasteropoden, &c., der Hierlatz-schichten. *Jahrbuch der. k. k. Reichsanstalt* (*Wien*).

1863 Lycett. Supplementary Monograph on the Mollusca from the Great Oolite, &c. Palæontographical Society.

— Day. Middle and Upper Lias of the Dorsetshire Coast. *Quart. Journ. Geol. Soc.*, vol. xix.

1863–69 Eugène Deslongchamps. Notes paléontologiques.

1864 Eugène Deslongchamps. Études sur les étages jurassiques inférieurs de la Normandie.

— Piette. Continuation de la Pal. Franç. *Alaria*, &c. No. 1 (5ème livraison).

1865–1866 Charles Moore. On the Middle and Upper Lias of the South-west of England. *Proc. Somersetsh. Arch. and Nat. Hist. Soc.*

1865 Brauns. Strat. und. Pal der Hilsmulde. *Palæontographica*, xiii.

1866 Stoliczka. Eine Revision der Gasteropoden der Gosau-schichten. *Berichte k. Acad. Wissensch.*

— Piette. Continuation de la Pal. Franç. *Alaria*, &c. No. 2 (9ème. livraison).

1867 Laube. Die Gasteropoden des Braunen Jura von Balin.

— Waagen. Die Zone des *Am. Sowerbyi*. *Benecke, Geognos. Beiträge.*

— Piette. Continuation de la Pal. Franç. *Alaria*, &c. No. 3 (12ème livraison).

1868 Rigaux and Sauvage. Bathonien du Bas Boulonnais.

— Stoliczka. Palæontologica Indica. *Mem. of the Geological Survey of India.*

— Gemmellaro. Studii paleontologici sulla Fauna del Calcare *à Terebratula janitor* (commenced).

1869 Terquem and Jourdy. L'Étage Bathonien de la Moselle.

— Brauns. Der Mittlere Jura.

— Wright. Correlation of Jurassic Rocks. *Proc. Cotteswold Naturalists' Field Club.*

— Piette. Continuation de la Pal. Franç. *Alaria*, &c. No. 4 (16ème livraison).

Between 1870 *and* 1879.

1870 Tate. Gloucestershire Lias. *Quart. Journ. Geol. Soc.*, vol. xxvi.
1871 Brauns. Der Untere Jura.
— Phillips. Geology of Oxford and the Thames Valley.
1872 Gemmellaro. Sopra alcune Fauna Giuresi e Liasiche (commenced).
1873 Tawney. Dundry Gasteropoda. *Proc. Bristol Nat. Soc.*, vol. i, part i.
1870–73 Sharp, S. On the Oolites of Northamptonshire. *Quart. Journ. Geol. Soc.*, vols. xxvi and xxix.
1874 Dumortier. Lias supérieur de l'est de France.
— Hudleston. Yorkshire Oolites (Lower). *Proc. Geol. Assoc.*, vol. iii.
1875 Judd. Geology of Rutland, with Palæontological Tables by R. Etheridge. *Mem. Geol. Survey.*
— Phillips. Geology of the Yorkshire Coast. 3rd edition.
1876 Tate and Blake. The Yorkshire Lias.
— Stoddart. Characteristic Fossils of the Dundry Oolite. *Proc. Cotteswold Naturalists' Field Club.*
— Gemmellaro. Studii pal. sulla Fauna del Calcare à *T. janitor* (concluded).
— Piette. Continuation de la Pal. Franç. *Alaria*, &c. Nos. 5—7 (livraisons 32, 33, 34).
1879 Buckman, J. On a Series of Sinistral Gasteropoda. *Proc. Dorset Nat. Hist. Soc.*, vol. iii.
1879–80 Witchell. Notes on a Section of Stroud Hill and the Upper Ragstone Beds of the Cotteswolds. *Proc. Cotteswold Naturalists' Field Club.*

Between 1880 *and* 1887 *inclusive.*

1880 Tate. Appendix to Woodward's Manual of the Mollusca. 4th Ed.
1882 Piette. Continuation de la Pal. Franç. *Alaria*, &c. No. 8 (livraison 57).
— Gemmellaro. Sopra alcune Fauna Giuresi e Liasiche (concluded).
— Tryon. Structural and Systematic Conchology.
— Witchell. On the Geology of Stroud.
— Crosse, H. Les Pleurtomaires de l'Époque actuel. *Journal de Conchyliologie.*
1882–85 Hudleston. Contributions to the Palæontology of the Yorkshire Oolites. *Geol. Mag.*
1883 Walford. On the Relations of the so-called Northampton Sand of North Oxfordshire to the *Clypeus*-grit. *Quart. Journ. Geol. Soc.*, vol. xxxix.
— —— Notes on Northamptonshire Fossils (Liassic). *Journ. Northamptonshire Nat. Hist. Soc.*

1883 Thompson. Upper Lias of Northamtonshire. *Op. cit.*

1884–85 Witchell. On the Upper Beds of the Great Oolite, &c., near Nailsworth. *Proc. Cotteswold Naturalists' Field Club.*

1885 Woodward, H. On Recent and Fossil *Pleurotomariæ*. *Geol. Mag.*, October, p. 433.

— Jukes-Browne and Dalton. Geology of S.-W. Lincolnshire.

— Cossmann. Gastropodes de l'étage Bathonien en France. *Mém. Soc. Géol. de France*, 3ème sér., T. 3ème.

1886 Fischer. Manuel de Conchyliologie, Gasteropoda (concluded, February, 1886).

— Vacek. Fauna der Oolithe von Capo S. Vigilio. *Abhandl. der k.-k. geologischen Reichsanstalt.*

— De Gregorio. Fossiles de Ghelpa, de San Vigilio, &c. *Annales de Géol., &c.*

1887 Witchell. On the genus *Nerinæa* and its Stratigraphical Distribution in the Cotteswolds. *Proc. Cotteswold Naturalists' Field Club.*

— Wilson. British Liassic Gasteropoda. *Geol. Mag.*, May and June.

N.B.—Many important works by De Loriol, Pellat, Contejean, Struckmann, and other palæontologists, relating exclusively to the Upper Jura, are reserved for a subsequent list.

DESCRIPTION OF GENERA AND SPECIES.

ORDER—PROSOBRANCHIATA, *Milne Edwards*, 1848.

Note.—As already observed in the General Introduction there are certain genera of Gasteropods whose family position is yet doubtful, and which have been variously located by different authors. *Purpurina* and *Brachytrema* are noteworthy instances of such uncertainty. It is proposed to consider these in the first instance without attempting to refer either genus to any particular family.

Genus—PURPURINA, *D'Orbigny*, 1850, Prod. i, p. 278.

Shell deeply and narrowly perforate, oval-elongate, tumid, thick; whorls rounded, rendered angular posteriorly by the sutural canaliculation; body-whorl large, ornamented with longitudinal ribs crossed by spiral striæ; aperture oval, subcanaliculate in front; columella arched; lip simple.—FISCHER.

Bibliography, &c.—Defined by Deslongchamps, 1860 ('Bull. Soc. Linn. Norm.,' vol. v, p. 136).

The history of *Purpurina* is rather singular. D'Orbigny gives a short diagnosis in the 'Prodrome,' and names several species from the Bajocian, Bathonian, Callovian, and Oxfordian; all of which perhaps belong to the genera *Brachytrema* and *Purpuroidea* of Lycett. In the 'Terrains Jurassiques,' as is well pointed out by Deslongchamps, numerous figures of *Purpurina* are given in the atlas, most of which belong to the genus *Eucyclus* (*Amberleya*). In the text D'Orbigny says nothing about the genus *Purpurina*, nor is there a word of description of any of the species figured. Fortunately there is just one figure of a most characteristic form, *P. bellona*, D'Orb. ('Ter. Jur.,' pl. 331, figs. 1 and 3), from the Inferior Oolite of Bayeux, and this has been accepted both by Piette ('Bull. Soc. Géol. de la France,' 2nd series, vol. xviii, p. 587) and by Deslongchamps for the type of a genus which, as defined by them, has relations on one side with *Turbo* and on the other with *Cerithium* and *Purpura*. "These shells," says Deslongchamps (vol. cit., p. 176; p. 24 of the separate 'Memoir on the Fossils of Montreuil-Bellay), "are characterised by a thick test, a small groove more or less pronounced in front of the mouth, especially in early life, by an umbilical slit of

very limited extent—by the whorls of the spire presenting longitudinal ribs more or less marked, cut by transverse striæ, a strong keel, or at least a very pronounced 'ressaut,' forming upon the whorl a 'meplat' towards the suture, which is deeply cut; finally a body-whorl much more developed than the others."

It is somewhat difficult to understand on what grounds Fischer places this genus under the Littorinidæ, and yet in the so-called *Purpurina bianor* and its allies there is a very strong resemblance to some sections of the numerously-represented genus *Amberleya* (*Eucyclus*). On the other hand, *Amberleya ornata*, D'Orb. (non Sow.), is very like a Purpurine, and was, in fact, recognised as such by Oppel ('Juraformation,' p. 387), who records it from the *Humphriesianus*-zone of Oeschingen, and also from the Bayeux beds. In well-preserved specimens of *Amberleya ornata*, D'Orb., the anterior groove or incipient canal is as well marked as in most Purpurines, and better perhaps than in the majority of specimens obtained by collectors. Thus there is certainly a link between *Purpurina* and *Amberleya*, though there may be no real affinity. Our difficulties are still further increased by the fact that Fischer classes *Amberleya* under the Turbinidæ. As regards the so-called canal in *Purpurina* it may be seen to vary from a very strong and well-defined channel with reflexed columella, such as those of *P. aspera* (Pl. I, fig. 11) and *P. calcar* (Pl. II, fig. 1), to the shallow, spoon-shaped grooves of *P. bellona* (Pl. I, fig. 5) and *P. inflata* (Pl. II, fig. 2). It should also be remembered that in the majority of specimens the anterior extremity has lost all original character from wear, so that we are only now and again permitted to see what the shell really was like.

Distribution, &c.—The duration of the genus appears to have been limited. The oldest form known to us in England is *P. ornatissima*, Moore, said to occur in the Marlstone of Ilminster (Moore, 'Middle and Upper Lias of S.-W. England,' p. 89, pl. v, figs. 20, 21), where it is described as being very rare. There is a somewhat similar form figured and described by Vacek (p. 53 (109), pl. 18, fig. 7) as *P. bellona*, D'Orb., from the *opalinus*-zone of the subalpine region. Nowhere are these pretty shells common, but in England they are the most abundant and best preserved in the Inferior Oolite of Dorsetshire, where the *Parkinsoni*-zone of Burton Bradstock yields for the most part different species to those characteristic of the *Sowerbyi*-bed of Bradford Abbas.

In the Inferior Oolite of the Cotteswolds *Purpurina* is rare, and usually in such indifferent preservation that the finer distinctions, held to constitute specific differences, can scarcely be made out. The same remarks apply for the most part to the Lincolnshire Limestone and Yorkshire Dogger. On higher geological horizons in England one species of *Purpurina* has been recognised in the Great Oolite (Bathonian), and another species in the Cornbrash and Kelloway Rock of

Yorkshire. Some of our Inferior Oolite species have very close representatives in the Callovian of Montreuil-Bellay in France.

Since the diagnosis of the genus given above will scarcely cover some of the extreme forms about to be included it will be necessary to constitute two sections, of which the first may be regarded as the normal or typical *Purpurina*, to which the above diagnosis may be fairly applied.

Section I.—Purpurina, *sensu stricto.*

Bellona Group.

1. Purpurina elaborata, *Lycett*, 1850. Plate I, figs. 1 *a*, *b*; 1 *c*, *d*, *e*; 1 *f*; 1 *g*.

1850. Turbo elaboratus, *Lycett*. Ann. Nat. Hist., vol. vi, p. 416, pl. ii, fig. 1.
1851–4. — — *Bean*. Morris, and Lycett, Gt. Ool. Moll., part 1, p. 64, pl. ix, fig. 27, and p. 116, pl. xv, fig. 2.
1854. — — — Morris, Catalogue, p. 282.
1869. Purpurina elaborata, *Bean*. Brauns, Mitl. Jura, p. 168.
1882. — — — var. Bajocensis, *Hudleston*. Geol. Mag., 1882, p. 195, pl. v, fig. 2.

Compare also *Purpurina bellona* of many Continental authors.

Bibliography, &c.—In addition to the above, "*Turbo elaboratus*" was described as a new species by Lycett, in a paper entitled "Tabular View of Fossil Shells from the Middle Division of the Inferior Oolite in Gloucestershire," published, 1853, in the 'Proceedings of the Cotteswold Naturalists' Field Club,' vol. i, p. 77.[1] There is certainly some difficulty in determining whether this species should be assigned to Lycett or to Bean, though it really makes very little difference. Morris and Lycett provide us with two types. One is from the Great Oolite of Minchinhampton or Bussage. This is in a good state of preservation, and may be seen at the Jermyn-Street Museum. The Yorkshire specimen (Pl. XV, fig. 2) is from the Scarborough Limestone (*Humphriesianus*-zone), and is in the Bean

[1] N.B.—No notice is taken of this paper by Morris in his 'Catalogue.' About 106 species of Gasteropods are tabulated, including some 56 new species, which are noted or briefly described. Two figures of Inferior-Oolite Gasteropoda are given. Several of the Inferior-Oolite species therein named and partially described by Lycett are preserved in the Jermyn Street Museum; some also have been described and figured in the "Great Oolite Mollusca." In those cases where the identification is certain, it will be convenient to adopt Lycett's name.

collection at the British Museum. Beyond the fact that it is a *Purpurina* very little else can be made out.

Morris and Lycett observe that *P. elaborata* has likewise been obtained from the Inferior Oolite (middle division) of the Minchinhampton district (p. 64), where specimens are said to be larger and more satisfactory (p. 117) than those from Scarborough. It has not been my lot to see any of these, though there are specimens of *Purpurinæ* from the Oolite-Marl devoid of any very distinctive features. Those authors speak of this species (p. 64) as occurring in the Inferior Oolite of Normandy, an allusion probably to *P. bellona*, which occurs on a higher horizon. On the whole *P. elaborata* must be regarded as a generalised form, which disputes with *P. bellona* the title to rank as the representative of the genus. In describing the really beautiful shells from the *Sowerbyi*-bed of Bradford Abbas under this title I have endeavoured to utilise an old name rather than invent a new one.

Description:

Length of a well-grown shell . . .	20 mm.
Ratio of width to length . . .	75 : 100.
Length of body-whorl to entire shell . .	66 : 100.
Spiral angle	76°.

Shell ovate-conoidal, apex acute. Whorls about five or six; posterior area tabulate, sides moderately tumid. The ornaments consist of about eighteen stout longitudinal costæ, which are feebly developed on the tabular area, rise up into spinous nodes on the keel, and are strong and regular in the flanks of the whorls. The costæ have a tendency to die out anteriorly on the body-whorl, a feature by no means confined to this species. The costæ decussate with regular and closely-set spirals, which extend down to the base of the shell; no spirals are seen on the flat area.

Aperture oval to subquadrate. Columella moderately reflexed so as to produce anteriorly a wide and shallow groove towards the point. Umbilical slit scarcely indicated.

Relations and Distribution.—The group of the Purpurinas to which *P. elaborata* belongs presents many features in common, and there can be no doubt that the several species run into each other to a very great extent. In fact, according to a lumping view of the case we might regard *P. elaborata-bellona* as one widely distributed species characteristic of the Inferior Oolite, and also represented in the Great Oolite of this country. When a badly preserved specimen turns up little more can be done than refer it thus. There is no doubt, however, that average specimens of D'Orbigny's *P. bellona*, which is fairly abundant in the "Oolithe ferrugineuse" of Normandy, present characters which on the whole differ constantly from average specimens obtained in the lower zones of the Inferior Oolite

in this country. In the typical *P. bellona* the spire is always higher, and the outline is more angular.

P. elaborata is somewhat scarce in the *Sowerbyi*-bed at Bradford Abbas. Most of the specimens found in the *Murchisonæ*-zone of the Cotteswolds must be referred here, as also the very stunted forms occasionally met with in the Lincolnshire Limestone. The *Nerinæa*-bed of the Yorkshire Dogger has yielded a very few characteristic specimens (N.B. The specimen from the Dogger, fig. 1 *g*, is very inferior to some since obtained). On the whole then, *P. elaborata* is the characteristic Purpurina of the Lower Division, whilst *P. bellona* is restricted to the Upper Division. One specimen from the *Murchisonæ*-zone of Normandy is in Prof. Deslongchamps' cabinet.

2. Purpurina : Species or Variety. Plate I, figs. 4 *a*, *b*.

1853. Cf. Turbo elaboratus, *Lycett*. Proc. Cotteswold Field Club, vol. i, p. 77, pl. ii, fig. 1.

Description.—Shell ovate; whorls about five, canaliculate towards the suture with subtumid flanks. The whorls of the spire are ornamented by stoutish longitudinal ribs, but these fail throughout the greater part of the body whorl. The spirals are moderately wide apart, and fine axial striæ may be noted in the interspaces.

The aperture is suborbicular, and the traces of the *Purpurina*-notch are very slight.

Relations and Distribution.—This species or variety possesses the flattened whorls of *P. elaborata* with much of the reticulate ornamentation of the species next described. The peculiar appearance of the aperture may be due to distortion, but it greatly resembles Lycett's figure in the 'Proc. Cotteswold Field Club.' The condition of the shell is such that no further comparisons can be made.

The specimen is from the Oolite-Marl. If a temporary name is required it might be known as Purpurina aperta.

3. Purpurina cancellata, sp. nov. Plate I, figs. 3 *a*, *b*.

Description :

Length	21 mm.
Ratio of width to length . . .	69 : 100.

Length of body whorl to entire shell . .	62 : 100.
Spiral angle	63°

Shell ovate-oblong, apex acute; spire about fourth tenths of the entire shell. Whorls five to six, angular, but the posterior area slopes outwards ; flanks scarcely tumid. There are about sixteen rather thin longitudinal costæ, which in the whorls of the spire are continuous, and form nodes at each of the keels; they also form nodes in the keel of the body-whorl, but die out anteriorly. The costæ decussate with spirals which are wide apart, wavy in outline, and about half the thickness of the longitudinals. This produces a regular network, of which the mesh is largest spirally. Spiral ornamentation of a fine character is also traceable on the posterior area.

Aperture very similar to that of *P. elaborata*, but with rather shorter columella. Very slight trace of the umbilical slit.

Relations and Distribution.—This pretty species has some resemblance to *Purpurina ornatissima*, Moore (*op. cit.*), from the Marlstone of Ilminster. But in Moore's species the shell is more ovate, the whorls are subtumid and very slightly tabulate. The ornamentation of Moore's species more resembles that of *P. elaborata*.

P. cancellata is described from a unique specimen in a very good state of preservation. It is stated to come from Stoford, and has much the appearance of a fossil from the *Sowerbyi*-bed.

4. Purpurina bellona, *D'Orbigny*, 1850. Plate I, figs. 5 *a*, *b* ; 5 *c*, *d* ; 5 *e*, *f*.

1850.	Purpurina	bellona,	*D'Orbigny*.	Prod. 1, p. 270.
1852.	—	—	—	T. J., 2, pl. 331, figs. 1—3.
1886.	Non —	—	—	Vacek, Fauna von Cap. S. Vigilio, p. 109, pl. 18, fig. 7.

Bibliography, &c.—This is the regulation name for most Purpurinas from the Inferior Oolite. I have already pointed out that D'Orbigny's type must have come from the "Oolithe ferrugineuse," and is therefore a fossil of the Upper Division. The species is capable of numerous subdivisions, some of which might almost be raised to the rank of species.

Description :

Length of a medium specimen . . .	21 mm.
Ratio of width to length . . .	66 : 100.
Length of body-whorl to entire shell . .	55 : 100.
Spiral angle	60°.

Shell ovate-oblong, turrited, apex acute. Spire nearly half the length of the

entire shell. Whorls about six, very angular. Posterior area flat, and forming a right angle with the sides, which are compressed and slightly undercut in the whorls of the spire. In the finer varieties (such as the specimen 5 *a*, *b*) there are from twenty-two to twenty-five longitudinal costæ on each whorl, but these only extend about half way down the body-whorl. These costæ form a circlet of slight spinous nodes on the keels, and are continuous over the flat area. The spiral ornamentation is similar to that of *P. elaborata*, and is not traceable over the flat area.

The aperture is ovate and relatively small; the pillar is short, and slightly reflexed, producing a broad and extremely shallow trough. Umbilical slit faint.

Specimens showing a bolder character of ornamentation are figs. 5 *c*, *d*, 5 *e*, *f*. Some of these have seven whorls. In the proportions and general shape of the whorls these do not differ materially from what has been already described; the ornamentation is simply coarser. In a large series every gradation may be seen.

Relations and Distribution.—In the character of its ornamentation, and in the rectangular outline of the whorls, there is considerable similarity between this species and *P. elaborata;* but the spire is higher, the shell less tumid, and the aperture somewhat more restricted.

In England *P. bellona* is most abundant in the *Parkinsoni*-zone of Burton Bradstock and that district, where some specimens occur with a higher spire than any shown on the accompanying plate. It also occurs in the *Cadomensis*-bed at Oborne. Specimens from the Upper Division in the Cotteswolds may, perhaps, belong here, but their condition is seldom good enough for specific determination.

5. Purpurina bellona, *D'Orbigny*, var. pagoda. Plate I, figs. 7 *a*, *b*, *c*.

1858. Cf. Quenstedt, Der Jura, *Turbo serratus*, p. 485, T. 65, fig. 7.

Description:

Length of a well-grown shell . . .	25 mm.
Ratio of width to length . . .	74 : 100.
Length of body-whorl to entire shell . .	60 : 100.
Spiral angle	68°.

The spiral angle is wider than in the more typical form. The posterior area of the whorls slopes outwards towards the keel, and then curves upwards before falling over, and the ornamentation on the keel is highly nodular.

Distribution.—P_1 of Burton Bradstock Cliff (p. 31) contains this form.

Another variety with sloping whorls (see Pl. I, fig. 9 *a*, *b*) is from the *Cadomensis*-bed at Oborne. This resembles the figure of a Dundry specimen given by Tawney

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in the "Dundry Gasteropoda," pl. 3, fig. 8, and referred by him (p. 3) to *P. bellona*, D'Orb.

Another variety (Pl. I, fig. 8 *a, b*) resembles *P. Orbignyana*, Héb. and Desl. ('Bull. Soc. Linn. Norm.,' v., p. 176, pl. i, fig. 6), described by them from the Callovian of Montreuil-Bellay. This is a Dorsetshire specimen, but the horizon is unknown.

6. Purpurina curta, sp. nov. Plate I, fig. 6 *a, b*.

This is a very squat form, of which I have found one or two examples in the *Humphriesianus*-zone. The specimen figured is from Millborne Wick.

It is not quite safe to describe this form as a variety of *P. bellona*, whilst its title to the rank of species can scarcely be regarded as proved at present.

7. Purpurina parcicosta, sp. nov. Plate I, fig. 10 *a, b*.

Description:

Length	21 mm.
Ratio of width to length . . .	80 : 100.
Ratio of body-whorl to shell . . .	60 : 100.
Spiral angle	78°.

Shell conoidal; spire about four-tenths of the entire length. Whorls five to six, angular, and broadly tabulate. Keels coarsely crenulate, and scarcely upturned. Costæ of the spiral whorls wide apart, and not prominent; anterior two-thirds of body-whorl scarcely costated, though the costæ are continuous across the flat area. Spirals coarse and few in number.

Aperture ovate. Columella short, and slightly reflexed, with a very broad and shallow groove. Umbilicus sometimes well marked.

Relations and Distribution.—In the tabulate character of the whorls, and to a certain extent also in the height of the spire, this species approaches *P. bellona* of the type shown in figures 5 *a—f*, and the very ovate aperture, and wide and shallow canaliculation, still further connect it. I have, however, other specimens where the canaliculation is stronger, and more like that of the species next described.

Rare in the Inferior Oolite of Dorsetshire.

8. Purpurina aspera, sp. nov. Plate I, figs. 11 *a*, *b*; 11 *c*, *d*; 11 *e*.

Description:

Length of a well-grown specimen . .	26 mm.
Ratio of width to length . . .	75 : 100.
Length of body-whorl to entire shell . .	60 : 100.
Spiral angle	70°.

Shell ovate-conoidal; spire rather more than four-tenths of the entire length. Whorls seven in number, angular; posterior area sloping outwards, anterior area sloping inwards. Keels submedian, and coarsely crenulate where the longitudinals or costæ cross over. Costæ few but prominent, and well-continued throughout the body-whorl except in the neigbourhood of the columella. The spirals on the posterior area of the whorls are fine and numerous, those on the anterior area are few in number (about three on the whorls of the spire), coarse and wavy. The spirals in the base are thicker and much striated longitudinally. Shell substance very thick.

Aperture subquadrate and rather restricted; columella encrusted and strongly reflexed, so that the anterior canaliculation is very pronounced. Umbilical slit narrowed and long.

Relations and Distribution.—This fine and characteristic Purpurine is, in many respects, widely removed from *P. elaborata*, and yet these two species are connected through the variety *pagoda*, and the numerous other varieties of *P. bellona*. Also, instead of the shallow anterior groove of that species, *P. aspera* is deeply canaliculate.

These very coarsely ornamented forms are characteristic of the *Sowerbyi*-bed of Bradford Abbas, where *P. aspera* is moderately abundant.

The specimen, Pl. I, fig. 2, is also from the *Sowerbyi*-bed of Bradford Abbas. It is an exceptional form, but I have not ventured to name it.

9. Purpurina calcar, sp. nov. Plate II, figs. 1 *a*, *b*.

Description:

Length	19 mm.
Ratio of width to length . . .	80 : 100.
Length of body-whorl to entire shell . .	60 : 100.
Spiral angle	75°.

Shell conical. Whorls about six, very angular; posterior area slightly sloping outwards, anterior area slightly sloping inwards. Keels of the whorls of the spire

strongly crenulate, keel of the body-whorl enormously so. Costæ wide apart, scarcely traceable anteriorly, but strongly developed below the keel, though dying out towards the base of the shell. Spirals above the keel fine and numerous; few and wide apart (two or at most three) below the keel. The body-whorl, including the base, has ten spirals.

Aperture subquadrate with an extremely short columella, strongly reflexed, so as to produce a notch of considerable depth. Hardly any trace of umbilicus.

Relations and Distribution.—Evidently related to the last-named species, *P. calcar* is extremely rare in the *Sowerbyi*-bed of Bradford Abbas. In this form we perceive the coarsest ornamentation of any species of *Purpurina* known to me.

Inflata Group.

10. Purpurina inflata, *Tawney*, 1850. Plate II, figs. 2 *a*, *b*, *c*; 2 *d*, *e*; 2 *f*.

1873. Purpurina inflata, *Tawney*. Dundry Gasteropoda, p. 4, pl. iii, fig. 9.

Bibliography, &c.—Mr. Tawney need not have apologised for making this species, which is much nearer to *P. Sowerbyi*, Waagen, than to *P. coronata*, Héb. and Desl., with which he tried to identify it.

Description:

Length of a well-grown shell . . .	24 mm.
Ratio of width to length . . .	80 : 100.
Length of body-whorl to entire shell . .	72 : 100.
Spiral angle	93°.

Shell ovate-globose; spire about three-tenths of the entire length. Whorls five to six, tumid, but flattened posteriorly and markedly canaliculate. Body-whorl much inflated. The longitudinals or costæ are numerous, regular, of moderate force, and with a slight slope from left to right. On the shoulder of the whorls each rib terminates in a slight spinous projection, forming a closely crenulated keel; the costæ extend about half way down the body-whorl. The spirals are fine, numerous, and regular, but are not seen to extend over the flat area.

Aperture ovate to semilunar, with a short and scarcely inflexed columella in the more adult specimens. In younger specimens the anterior groove is better marked, and the umbilical slit is also more apparent.

Relations and Distribution.—This species may be regarded as typical of the more globular forms of *Purpurina*, which are found both in the Inferior Oolite of the Anglo-Norman basin, and also in the Callovian of Montreuil-Bellay. It is undoubtedly near to *P. Sowerbyi*, Waagen, but rather more tabulate.

P. inflata is characteristic of the *Parkinsoni*-zone of Burton Bradstock and the neighbourhood. The *Sauzei*-bed at Oborne also yields it, and specimens resembling this species are in Mr. Buckman's collection, said to come from East Coker, zone unknown. It also occurs at Dundry, and in the Inferior Oolite of Rodborough Hill, and Cold Comfort.

In Normandy it is fairly abundant in the "Oolithe ferrugineuse," whence many fine specimens are to be seen in Prof. Deslongchamps' collection.

11. PURPURINA: Cf. SOWERBYI, *Waagen*, 1867. Not figured.

1867. PURPURINA SOWERBYI, *Waagen*. Zone of *Am. Sowerbyi*, in Benecke, p. 105, pl. v, figs. 3, 4 *a, b, c*.

A globose *Purpurina* which differs from *P. inflata*, in having the shoulder of the whorl sloping, and scarcely canaliculate, is of rare occurrence in the *Sowerbyi*-bed of Bradford Abbas. The spire also is rather shorter, and the costæ have a more decided inclination from left to right.

12. PURPURINA ROTUNDA, sp. nov. Plate II, figs. 3 *a, b, c*; 3 *d*.

Description:

Length of well-grown shell . . .	23 mm.
Ratio of width to length . . .	82 : 100.
Length of body-whorl to entire shell . .	68 : 100.
Spiral angle	90°.

Shell ovate-globose, rather widely umbilicated. Whorls five to six, tumid and canaliculate near the suture; body-whorl much inflated. The costæ are feebly developed on the whorls of the spire, and more or less effaced on the body-whorl. The spirals are numerous and regular in their increase and relative distance.

Aperture widely ovate, with but slight traces of canaliculation.

Relations and Distribution.—Though not more tumid than *P. inflata* this is the most globose of all the Purpurines. It is further distinguished by a good sized, circular umbilicus. The aperture is, perhaps, the least canaliculate of any known species.

Rare in the *Sowerbyi*-bed of Bradford Abbas and Stoford.

13. Purpurina tabulata, sp. nov. Plate II, figs. 4 *a*, *b*, *c*.

Description:

Length of a large specimen . . .	20 mm.
Ratio of width to length . . .	80 : 100.
Length of body-whorl to entire shell . .	70 : 100.
Spiral angle	90°.

Shell conoidal, subglobose, almost imperforate. Whorls about six, angular and widely tabulate, slightly tumid on the flanks. The longitudinal ornament is very feeble, especially in the body-whorl; it is better shown on the tabular area, where the costæ are split by lines of growth. The keels are delicately crenulate. The spirals are regular, numerous, and rather fine; they do not extend over the tabular area.

Aperture ovate to subquadrate, wide, and bearing considerable resemblance to that of *P. elaborata*.

A less tumid variety (Pl. II, fig. 4 *d*, *e*), with better developed costæ, serves to connect this species with *P. curta* (Pl. I, fig. 6 *a*, *b*), which, however, has well-developed costæ and a somewhat longer spire. This variety might be called P. subcoronata.

Relations and Distribution.—*P. tabulata* is near to *P. coronata*, H. and D. ('Foss. Mont.-Bellay,' p. 25, pl. i, fig. 7), but that small and tabulate species is beautifully cancellated.

Rather rare in the *Sowerbyi*-bed of Bradford Abbas and Stoford.

The following list summarises the results as regards the Purpurines, strictly so called, of the Inferior Oolite in England.

Bellona Group.

Purpurina elaborata, *M. and L.*	Purpurina curta, *sp. nov.*
— "aperta."	— parcicosta, *sp. nov.*
— cancellata, *sp. nov.*	— aspera, *sp. nov.*
— bellona, *D'Orb.*	— calcar, *sp. nov.*
— — — var. *pagoda.*	

Inflata Group.

Purpurina inflata, *Tawney.*	Purpurina rotunda, *sp. nov.*
— cf. Sowerbyi, *Waagen.*	— tabulata, *sp. nov.*

Section II.—Purpurina, *Auctorum nonnullorum.*

A considerable modification in the diagnosis of the genus is required to admit the following species; where the spire is longer, the body-whorl less tumid, and the whole shell angular and eucycloid. Indeed, I should prefer to distinguish this group as *Eucycloidea*—small shells with carinated whorls; carinæ median and crenulate; aperture rhomboidal, with a short and narrow anterior canaliculation.

14. Purpurina (Eucycloidea) bianor, *D'Orbigny*, 1850. Plate II, figs. 5 *a*, *b*, *c*; 5 *d*, *e*; 5 *f*, *g*, *h*.

1850. Turbo bianor, *D'Orbigny*. Prod. 1, Ét. 10, p. 266.
1852. Purpurina bianor, *D'Orbigny*. Ter. Jur. 2, pl. 331, figs. 14, 15.
1860. Cf. also Purpurina granulata, *Héb. and Desl.* Foss. de Montreuil-Bellay, p. 28, pl. 7, fig. 9.

Bibliography, &c.—I can find no adequate description of *P. bianor*. In the Prodrome, D'Orbigny merely says that *T. bianor* is near to *T. belia*, but more elongate, more carinate in the middle of the whorls, and without crenulations. Occurs at Port-en-Bessin. In the 'Terrains Jurassiques' no text accompanies the figure of *P. bianor*. On the other hand, our shell greatly resembles specimens from Normandy, which Prof. Deslongchamps and other palæontologists refer without hesitation to *P. bianor*, D'Orb. These occur in the beds of Bayeux.

P. granulata, H. and D., greatly resembles some of the larger specimens from Vitney Cross, but on the whole the ornamentation of *P. granulata* is richer, especially on the carinæ. But if the Vitney Cross specimens were as well preserved as those from the Callovian of Montreuil-Bellay, it might, perhaps, be more difficult to indicate the difference.

Description:

Length of a well-grown shell . . .	13 mm.
Ratio of width to length . . .	65 : 100.
Length of body-whorl to entire shell . .	55 : 100.
Spiral angle	55°.

Shell conical, eucycloid; spire nearly half the length of the shell, apex sharp. Whorls about seven in well-grown specimens, very angular, having a strong keel, which is median in the whorls of the spire; body-whorl with one strong keel, and showing no distinctive base. The keels are regularly and finely crenulate (differing

from D'Orbigny's description), and where this is not so, it would seem to be the result of wear. The spirals are often faint, except in the lower part of the body-whorl, where they are more prominent; but there is much variation in this respect. On the whole, the spirals are fewer and stronger in the anterior than in the posterior area of each whorl, and in well preserved specimens are seen to be decussated with fine longitudinal striæ.

Aperture subquadrate, inclining to rhomboidal; columella scarcely reflexed; anterior groove more marked in some specimens than in others. Umbilical slit variable.

Relations and Distributions.—The forms described below, viz. *P.* "*fusiformis*" and *P. carino-crenata*, are probably nothing more than varieties of the somewhat variable species identified as *P. bianor.* But this section of the genus *Purpurina*, as was noticed by Hébert and Deslongchamps in dealing with *P. granulata*, recalls the form of *Amberleya* (*Eucyclus*) with considerable force. It will be remembered that many species of eucycloid *Purpurinæ* were figured by D'Orbigny in the 'Terraines Jurassiques,' *e.g. P. ornata*, *P. bathis*, *P. belia.* Forms greatly resembling these our palæontologists have hitherto treated as belonging to the genus *Amberleya.* It is difficult to say where the line should be drawn, since many of the shells referred to *Amberleya* show considerable anterior grooving when well preserved. Altogether, the section of *Purpurina* which contains *P. bianor* is anomalous, and full of difficulty, as we shall perceive in the sequel.

In this country *P. bianor* is essentially a fossil of the *Parkinsoni*-zone, being fairly abundant in P_1, Burton Bradstock Cliff, and in the same horizon at Vitney Cross, and Upper Loders. In North Dorset it occurs sparingly in the *Parkinsoni*-beds at Halfway House and Bradford Abbas.

15. Purpurina (Eucycloidea): Species or Variety related to P. bianor. Plate II, figs. 6 *a*, *b*.

This shell differs from the preceding in having a somewhat smaller spiral angle, and in its more fusiform outline. The body-whorl presents a distinctly defined base, and the anterior portion of the whorls of the spire has less of an inward slope; consequently the whorls are less angular. The keels are richly crenulate; the spirals above the keel consist of a well-marked line near the suture, and two others which are fainter; the spirals below the keel are two in number and stronger; all are finely decussated by axial striæ.

Aperture imperfect, but probably like the preceding.

It is not impossible that this form may be a poor representative of *Turbo sub-*

angulatus, Münst. ('Goldf. Petref.,' t. 194, f. 5), a fossil of the *Murchisonæ*-zone identified by Oppel with *P. patroclus*, D'Orb. ('Ter. Jur.' 2, pl. 329, figs. 9—11). As a temporary name I propose that our shell be called "*Purpurina fusiformis*." It belongs to the Woodwardian Museum, and is marked "Yeovil." Hence I presume it is a fossil of the Lower Division of the Inferior Oolite.

16. PURPURINA (EUCYCLOIDEA) CARINO-CRENATA, *Lycett*, 1853. Plate II, figs. 7 *a*, *b*.

1853. FUSUS ? CARINO-CRENATUS, *Lycett*. Proc. Cotteswold Nat. Field Club, vol. i, p. 81.

Description—"Shell small, fusiform; spire of four volutions, keeled and striated; an elevated carina encircles the middle of each whorl, its edge undulated or crenulated; encircling striæ cover the whole surface of the shell, and there is an indistinct circle of nodules upon the upper portion of each whorl near the junction."—LYCETT.

The specimen now figured answers to the above description, except that possibly the spire may have had five whorls. It evidently belongs to the same section of *Purpurina* as *P. bianor*, but obviously differs in the smaller spiral angle, and in possessing a more defined base (not well shown in Fig. 7 *a*, *b*); in fact, the body-whorl may be regarded as distinctly bicarinate. The character, though not the details of the ornamentation, are similar. With "*P. fusiformis*" it has closer affinities, but the Cotteswold shell is much feebler.

This specimen is from the Lycett Collection in the Jermyn Street Museum, and is the only one known to me. The author quotes the species from the Inferior Oolite of Minchinhampton (*op. cit.*, p. 73).

Some other small fossils from the Inferior Oolite have lately turned up which may belong here, but at present it seems safer to reserve these to be dealt with subsequently, either by way of postscript or otherwise.

Genus—BRACHYTREMA, *Morris and Lycett*, 1851, Great Ool. Moll., p. 24.

"*Shell small, twisted, turbinated, solid. Whorls nodular, costated or cancellated; the last whorl large and ventricose; columella smooth, rounded; twisted near to the base, and reflecting outwards, forming a short oblique canal; aperture moderately subovate, less frequently thickened, and externally subvaricose.*"—FISCHER, 'Man. Conch.,' p. 685.

The above is in the main the original diagnosis of Morris and Lycett, which had to a certain extent been modified by Piette in 1856. To show the uncertainty which still prevails with regard to the family position of *Brachytrema*, I would refer to the partial list of genera, p. 12 of this Monograph. It will be seen that Fischer places the genus with a query under Cerithiidæ, Tryon places it under Littorinidæ or Cerithiidæ, Tate under Cerithiidæ provisionally, Stoliczka under Cerithiidæ. Morris and Lycett, on the other hand, originally regarded it as related to the Muricidæ.

These shells are very scarce and poorly preserved in the Inferior Oolite of England, so that our opportunities for adding to the knowledge we possess of the genus have not been great. Omitting the more fusiform shells which have occasionally been referred to *Brachytrema*, two distinct groups are apparent, one of which is like *Purpuroidea* in its aspect (*B. Wrightii*); the other might with more justice be regarded as related to the family of the Cerithiidæ (*B. subvaricosum*). Thus the genus is to be regarded as a composite one, which possibly may be broken up when the subject has been more fully ventilated.

17. Brachytrema subvaricosum, sp. nov. Plate II, figs. 9 *a*, *b*.

Description :

Length	6·25 mm.
Width	4·12 mm.
Length of body-whorl to entire shell, about .	50 : 100
Spiral angle	50°

Shell small, subconical, apex pointed. Whorls six, nearly flat, and without strong sutural depressions. The ornaments consist of three stout, undulating spirals, which are wide apart, though somewhat fused together in the apical whorls. In the body-whorl a fourth spiral is developed; and in the base the spirals are fine and not numerous. The longitudinal ornamentation is irregular and not conspicuous, though slightly variciform in character.

Aperture subquadrate and somewhat restricted, canal short, columella curved, notch narrow.

Relations and Distribution.—Brachytrema brevis, Piette ('Bull. Soc. Géol. France,' 2me sér., vol. xiii, p. 564, pl. xv, figs. 21, 22), believed to be nearly the same as *Turbo pygmæus*, M. and L. ('Great Ool. Moll.,' p. 65, pl. ix, fig. 29), approaches this species very closely. *B. subvaricosum* is less depressed, and the longitudinal ornamentation is less sharply developed; the spirals are larger, wider apart, and less numerous than in *Turbo pygmæus*. *B. varicosa*, Lyc. ('Suppl.,'

p. 5, pl. 44, fig. 27), approaches our shell still more closely, but the spiral ornamentation of Lycett's species is finer, more crowded, and more granulated. It is true that in all these cases the differences are chiefly connected with the ornamentation, and in this respect *B. subvaricosum* certainly differs from all known forms of *Brachytrema* in the Great Oolite of this country. It is possible that this may be the form described by Cossmann (p. 79, pl. xi, figs. 34 and 35) as *Brachytrema brevis*, Piette, said to be not uncommon in the Bajocian of the Meurthe-et-Moselle.

Brachytrema subvaricosum occurs sparingly in the upper part of the Lincolnshire Limestone at Great Ponton. There is also a wide-angled variety, with the spirals very wide apart, which has been found at Weldon.

18. Brachytrema binodosum, sp. nov. Pl. VII, fig. 12.

Description.—This little shell differs from all others of the *varicosum*-group in having two nodular spiral belts round the whorls, which give it an eucycloid aspect. A single specimen has been found at Great Ponton.

19. Brachytrema Wrightii, *Cotteau*, 1855, var. despecta. Plate II, figs. 8 *a*, *b*, *c*.

1860. Brachytrema Wrightii, *Cotteau.* Héb. and Desl., Foss. de Montreuil-Bellay, p. 21, pl. vii, figs. 7 *a*, *b*, *c*.

Description:

Length	7·5 mm.
Width	6 mm.
Body-whorl to entire shell, about	55 : 100
Spiral angle	65°

Shell conical; apex pointed. Whorls five, angular, and step-like; ornaments coarse; three strong nodulated spirals on the anterior area of each whorl; the longitudinals consist of tolerably numerous stout costæ which are very nodular over the angle of the whorl; base rather flattened and ornamented by five spiral lines.

Aperture subquadrate to circular; notch rather wide; scarcely any canal.

Relations and Distribution.—Owing to the indifferent preservation of the anterior margin of the only known specimen it is not easy fully to point out how the form now under consideration differs from Cotteau's species. It is not much

more than one-third the size, is wider-angled, and has a flatter base; the notch also is probably wider and more distinct. There is an undescribed species of *Brachytrema* in the Bajocian of Normandy (for a specimen of which I am indebted to the generosity of M. Deslongchamps), which greatly resembles this form, and also *B. Wrightii*, but yet has points of difference from both. These differences are probably not more than varietal. *B. Wrightii* and its allies represent the group of Brachytremas which are related to *Purpuroidea*. In the well-preserved specimens of the French Bajocian it is possible to note this relationship.

The variety *despecta* is founded on a unique specimen from P_3, Vitney Cross (see p. 38), and is the only *Brachytrema* that has hitherto to my knowledge been found in the Inferior Oolite of England outside of the Lincolnshire Limestone. If additional evidence as to its differing materially from *B. Wrightii* should be obtained, the species may be known as Brachytrema despectum.

Family APORRHAÏDÆ.

"*Shell turrited, aperture continued in front by an imperfect canal or a groove; lip expanded, aliform or digitate.*"—Fischer.

The Inferior Oolite, in England, contains three genera, which may be referred to this family, viz. *Malaptera*, Piette, *Spinigera*, D'Orbigny, and *Alaria*, Morris and Lycett. These genera are probably of unequal value, and it might perhaps be difficult to give a very rigorous and logical definition of any one of them, so linked are they to all appearance by connecting forms. Besides the three named genera there are one or two species of the Aporrhaïdæ, which seem rather difficult to place under any of the above.

The Cretaceous Aporrhaïdæ have received a considerable amount of attention from Mr. J. Starkie Gardner,[1] and, in common with some other conchologists, he failed to see any difference of generic value between *Alaria* and the existing *Aporrhais*. However, Fischer clearly endorses Piette's view as to the propriety of keeping *Aporrhais* distinct from at least the bulk of the shells usually referred to *Alaria*; and the farther we go back in time, the more the *Alaria*-group predominates over the others, until its origin is lost in the small and often obscure forms, which a minute and careful search is gradually revealing from the Lias.

[1] "On the Gault and Cretaceous Aporrhaïdæ," by J. Starkie Gardner, F.G.S., 'Geological Magazine,' 1875.

Genus—Malaptera, *Piette.*

"*Shell thin, fusiform or ovoid, wing very large, multidigitate, palmate, investing, bent back, extended on the columellar side, and sometimes on the posterior portion of the spire; anterior canal placed upon an expansion which forms part of the wing, and consisting of a wide furrow bent backwards as in* Aporrhais."—Fischer.

Such a genus as this possesses more resemblance to the existing *Aporrhais* than the average Jurassic *Alaria* does. Indeed, Cossmann ('Étage Bathonien,' p. 71) regards *Malaptera* as merely a subgenus of *Aporrhais.* Most of these shells were formerly referred to *Pterocera*, Lamarck.

20. Malaptera bentleyi, *Morris and Lycett*, 1851. Plate III, figs. 1 *a*, 1 *b*, 1 *c*.

1851.	Pterocera Bentleyi, *Morris and Lycett.*	Great Ool.-Moll., p. 15, pl. iii, figs. 15, 15 *a*.
1854.	— — —	Morris, Catalogue, p. 274.
	Cf. also Chenopus Pictaviensis, *D'Orbigny.*	Piette, Cont. de la Pal. Franç., pl. xiv, fig. 9, and pl. xix, figs. 10 and 11.

Bibliography, &c.—This is an Inferior-Oolite species described by Morris and Lycett as from the Great Oolite; but no similar form is known in the Great Oolite of this country.

Description:

Length of a full-sized specimen	32 mm.
Ratio of width to length	46 : 100.
Spiral angle	36°.

Shell turrited, spiral angle rather convex, apex blunt. Whorls angular and tumid; posterior third of each whorl marked with very fine spiral lines, for the most part scarcely visible; the anterior two-thirds carries four strong spiral lines. Body-whorl moderately large, and nearly equal to the length of the spire. It is ornamented by six strong spirals, from which the digitations of the wing arise. The wing embraces a very considerable portion of the spire. The posterior digitations are the strongest and also the widest apart, the first one being bent upwards, so as to form an angle of about 10° with the axis of the spire and nearly straight; the three anterior digitations are less strong, and project much less farther from the edge of the palmated portion of the wing; they are bent downwards in an

increasing ratio. The anterior portion of the wing is ornamented by numerous fine lines. The principal digitations are six, but a subordinate seventh occurs.

The aperture is short and nearly quadrate; the six or seven furrows of the wing, corresponding to the digitations, radiate from the outer lip, and the posterior furrows communicate directly with the aperture. The canal is very wide at first, but tapers gradually to a tolerably fine groove, as the anterior spine, or canal-sheath is bent back almost in the form of a sickle.

Relations and Distribution.—This species is of considerable interest as probably the oldest *Malaptera* known. The Collyweston Slate cannot well be higher than the middle part of the *Murchisonæ*-zone. Poor specimens are occasionally obtained from the neighbouring Lincolnshire Limestone, but the species has probably not been found out of the Stamford district. It is by no means uncommon at Collyweston.

21. Malaptera bentleyi, *M. and L.*, var. neglecta. Plate III, fig. 2.[1]

Cf. Morris and Lycett, Great-Ool. Moll., pl. iii, fig. 16.

This differs from the more usual form, (1) in being smaller, (2) the whorls of the spire being rather more angular and the ornamentation finer; (3) the posterior digitation more recurved upon the spire; (4) the anterior digitations scarcely perceptible.

Genus—Spinigera, *D'Orbigny*, 1850.

"*These are Rostellarias compressed and with successive lateral varices, like* Ranella, *but which have at each varix a long point.*" 'Prod.,' vol. i, p. 270. Étage Bajocien.'

Fischer ('Manuel,' p. 677) regards *Spinigera* as merely a subgenus of *Alaria*. He gives the following diagnosis. "Shell elongate, narrow, fusiform; anterior canal long, straight; varices continuous, aligned on one side or on both sides, as with *Ranella*, and provided with a long spine directed transversely." The compression of the shell, originally diagnosed by D'Orbigny, seems to me also an important feature, and helps to distinguish *Spinigera*, which represents a curious section of the Aporrhaïdæ, placed at the opposite extremity of the scale to that of *Malaptera* and its allies.

[1] N.B.—This figure and fig. 1 *c* were drawn from reversed casts in gutta-percha.

This genus is limited both vertically and horizontally. In England it is almost exclusively confined to the Inferior Oolite of Dorsetshire, with a stray specimen from Dundry. In France the type species, *Spinigera longispina*, Desl., is not uncommon in the beds of Bayeux. In the singular repetition of the Bayeux-beds on a Callovian horizon, which occurs at Montreuil-Bellay, two species of *Spinigera* are found, according to the determinations of MM. Hébert and Deslongchamps. The Bathonian beds in France have not yielded any, and this is also the case as regards our own Great Oolite.

The Dorsetshire beds of Inferior-Oolite age, and especially those of Bradford Abbas, provide us with some interesting forms. Five species may be noted, of which three are probably new. Like *Alaria* some are monodactyl, as *Sp. recurva*, where the last lateral spine appears to have the function of a wing-digitation; others, like *Sp. didactyla*, have two wing-digitations when adult. The spines are in many cases seen to be hollow in section, showing that they were channelled or perforated.

Owing to the compression, which appears characteristic of the genus, it would be useless to attempt any comparison by means of the spiral angle. In all cases the shell is more or less elongate, fusiform, and compressed.

22. Spinigera trinitatis, *Tawney*, 1873. Plate III, figs. 3 *a*, *b*; 3 *c*, *d*, *e*.

> 1873. Alaria trinitatis, *Tawney*. Dundry Gasteropoda, p. 12, pl. i, fig. 6.
> Cf. also Rostellaria spinosa, *Münster*. Goldfuss, iii, p. 15, pl. 170, fig. 2.

Bibliography, *&c.*—Mr. Tawney, in describing his species, admitted that the materials were very imperfect; and this we can easily believe, since it would be difficult to conjecture from the figure given in the 'Dundry Gasteropoda,' that the specimen was a *Spinigera*. However, there was enough to distinguish it from "*Alaria*" *longispina*, Desl.

Sp. trinitatis is probably closely related to *Rostellaria spinosa*, Münster. At any rate the species from the Jura-kalk of Pappenheim is evidently a *Spinigera*, and resembles this species rather than *Sp. longispina*, Desl.

Description:

Length[1]	18 mm.
Ratio of minor to major axis of width . .	53 : 100.

Shell elongate, fusiform. Whorls of spire extremely flattened, body-whorl less so; apical whorls smooth and tumid; next whorl has a median costated keel

[1] In all cases the canal is excluded.

(fig. 3 *b*); then comes a whorl with a keel nearly median and finely crenulated; each of these whorls presents a fine basal rim just above the suture. The four or five remaining whorls, including the body-whorl, have the keel almost at the anterior extremity; traces of the fine crenulation are seen on the keels of the two higher whorls, but this is almost obliterated on the penultimate and body-whorl. In the four or five last whorls there are two fine spiral lines above the keel, and one below; these are decussated by numerous fine radial lines, often indistinct. The four or five last whorls also develop a continuous chain of bilateral varices (fig. 3 *e*), each of which sends out a spine on crossing the keel (not always visible).

Aperture subovate, elongate; canal very long and straight. Without wing, except so far as the antero-lateral spine, originating in the varix, and not in the outer lip, represents one.

Relations and Distribution.—This species is extremely variable, especially as to the position of the keel in the anterior whorls. Occasionally the body-whorl is more angular, and in such cases specimens are not always to be distinguished from *Sp. didactyla.* Indeed, it is possible that *Sp. trinitatis* represents an incomplete stage of that very bizarre form.

Somewhat rare in the *Sowerbyi*-bed of Bradford Abbas, and quoted also from Dundry.

23. Spinigera longispina, *Deslongchamps*, 1842. Plate III, figs. 4 *a*, 4 *b*, 4 *c*.

1842. Ranella longispina, *Desl.* Mém. Soc. Linn. Norm., vol. vii, p. 152, pl. xi, fig. 29.

Bibliography.—This being the type of the genus, most forms of *Spinigera* hitherto found in the British Oolites have been thus referred to by collectors. Deslongchamps' species is, however, in reality almost unknown in our collections, and unless great pains be taken to show the spines it has so much the appearance of an *Alaria* that few would suspect its real nature.

Description:

Length	35 mm.
Ratio of minor to major axis of width . .	80 : 100

Shell elongate, fusiform. Whorls subventricose and only slightly compressed. Apical whorls subglobular; next succeeds an intermediate whorl, subangular, with a median keel, and traces of axial costæ anteriorly; the remaining six whorls, including the body-whorl, have the keel less and less median until its position is at about the lower third. The ornaments consist of numerous spiral lines, which have moderately wide interspaces, and are carried over the bilateral varices in undu-

lations. At the junction with each keel and the varices a spine is developed and generally nearly at right angles to the axis of the shell, sometimes with a slight anterior deflection. These spines are always situated about two-thirds down the whorl; above the base of each spine is a slight corrugation of the varix but no more than one spine on each side of the whorl.

Aperture ovate-oblong to subquadrate; no regular wing, since the anterior lateral spine springs from the varix and not from the outer lip; canal long and straight. N.B.—There seems a certain amount of irregularity in the development of the spines, but on the whole the arrangement is distinctly bilateral, though in some cases the spines appear better developed on one side than on the other.

Relations and Distribution.—Nearly related to the succeeding species, *Sp. longispina* is in this country eminently characteristic of the *Humphriesianus*-zone, where alone I have succeeded in finding it. The three figured specimens are all from the Sherborne district. The *Sauzei*-bed at Oborne contains a very inflated variety. Mr. Wilson has lately found a specimen in the iron-shot Oolite of Dundry, which seems to present features intermediate between this species and those of the one next described, though inclining towards *Sp. longispina.*

24. Spinigera recurva, sp. nov. Plate III, figs. 5 *a*, 5 *b*; 5 *c*, *d*, *e*; 5 *f*, *g*, *h*.

Description :

Length (full size) . .	22 mm
Ratio of minor to major axis of width . .	75 : 100

Shell rather short, fusiform, and moderately compressed. Apical whorls four, subglobular and plain (fig. 5 *h*), constituting the opening of a very convex spiral angle; next whorl angular and costated longitudinally; the succeeding whorls of the spire (three or four) have either no longitudinals or at best very faint ones, but are spirally ornamented throughout, and betray a tendency to bicarination which varies in different specimens but is generally well marked. The body-whorl exhibits a third carina, sometimes also visible in the penultimate. The chain of bilateral varices is more or less continuous, but a spine is always sent out on both sides where the varix crosses the lower keel (fig. 5 *e*). The direction of the spines is irregular, those on the body-whorl have mostly a tendency to curve upwards.

Aperture very nearly quadrate and graduating into a wide and straight canal. There is no actual wing, but in the well-preserved specimen, fig. 5 *a*, the spines are seen to be grooved, and the groove in the anterior lateral spine is seen distinctly to communicate through a notch in the outer lip with the aperture, hence it may also be said to have the function of a wing.

Relations and Distribution.—Distinguished from *Sp. longispina* in being much shorter, although with nearly the same number of whorls ; also in the marked bicarination of the anterior whorls, and to a certain extent in the direction taken by the spines, some of which have a tendency to curve upwards. It is also more compressed and the whorls less tumid. *Spinigera compressa*, D'Orb. (Héb. and Desl., p. 18, pl. vi, fig. 8), from the Callovian of Montreuil-Bellay, which species is regarded by the authors as synonymous with *Muricida fragilissima*, Quenstedt ('Der Jura,' tab. 65, fig. 30), is a small form rather nearer to *Sp. longispina* than to this species.

Spinigera recurva is essentially a fossil of the lower part of the *Parkinsoni*-zone of South Dorset (P_1), being far from uncommon in the cliffs of Burton Bradstock and Bridport Harbour, likewise in the quarries of the interior, especially at Vitney Cross. I have also a stunted variety from Broadwinsor, showing more ornamentation than usual in the subapical whorls. The species has been recognised by M. Deslongchamps in the Bajocian of Normandy as one hitherto unnamed. Undoubtedly the differences which separate it from *Sp. longispina* are not very great, and some might be disposed to regard it as a variety. At the same time these differences are constant or nearly so, and are coincident with a change of horizon. When we feel sure that such is the case it seems only reasonable to "make a new species."

25. Spinigera didactyla, sp. nov. Plate III, figs. 6 *a*, 6 *b*, 6 *c*; 6 *d*, *e*, *f*, *g*.

Description.—This is a very variable shell, especially as to size and angular measurements; or, stated in other terms, several forms presenting considerable differences of size and outline are grouped under one specific distinction. The dimensions, therefore, must be given subsequently under the heading "varieties."

Shell elongate to sub-elongate, fusiform, and greatly compressed. Apex very blunt. The three apical whorls smooth and tumid; the whorls immediately succeeding have a median costated keel; the two costated whorls show a basal rim above the suture. The rest of the shell, consisting usually of five whorls in the longer varieties, and of four whorls in the shorter varieties, is nearly plain, or provided only with fine spiral lines. The keel is well developed, and ranges from submedian to anterior in position. These whorls develop the bilateral varices, which send out short spines on crossing the keel. The body-whorl is strongly bicarinate, sending out from each keel two long channelled bifurcating spines, which greatly resemble the double wing of the didactyl Alarias.

The aperture is subquadrate or trapezoidal, with the outer lip distended over

the wing and in communication with the channelled digitations. Canal long and straight, but no complete termination has been seen.

Varieties and Dimensions.—In the longer varieties, which constitute a considerable majority, the degree of compression, or ratio of minor to major axes of width, which might be called the index of compression, is as 57 to 100. In the shorter and wider varieties it is about as 50 to 100, *i. e.* one side of the shell is twice as wide as the other. From 15 to 20 mm. in length seems to be about an average for the narrower varieties. The large specimen (fig. 6 *a*) measures upwards of 30 mm., but this must be regarded as a megalomorph. The length in this case is gained not by an additional number of whorls, but by the greater height of each.

In the wide variety (fig. 6 *d*, and enlargements) the apical whorls resolve themselves into an almost undistinguishable nucleus, the two costated whorls are in their place, and the remainder of the shell appears in all cases to consist of four instead of five whorls. Hence this variety seems to have arrived at maturity earlier. The length of this variety may be taken at from 12 to 13 mm.

Relations and Distribution.—This curious species helps to show the analogy which exists between *Alaria* and *Spinigera.* Unless we are prepared to believe that *Sp. trinitatis* is a young or undeveloped form of *Sp. didactyla,* the latter stands almost alone. If *Spinigera trinitatis* be an undeveloped form, then the two species, though related, might be regarded as distinct. But if *Sp. trinitatis* be merely the young stage of the other, then it is clear that they only form one species. The point is a difficult one and not easy to decide. There is a considerable degree of resemblance in the more apical portions of the spire. On the whole the anterior whorls, which make up the bulk of the shell, are less angular in *Sp. trinitatis,* and show more spiral ornamentation.

Both forms are mainly confined to the *Sowerbyi*-bed at Bradford Abbas, and in my own collection *Sp. didactyla* is the most numerous. These species are apparently not known to occur in the Inferior Oolite of Normandy.

26. Spinigera crassa, sp. nov. Plate III, fig. 7.

Description.

Length about . . . . 25 mm.

Shell subelongate, fusiform. Apex unknown. Whorls stout and subangular (seven remain), with a strong keel placed towards the anterior extremity. No spiral ornament visible, but the whorls are rugose with axial lines, most probably of growth. The bilateral varices in the only available specimen are not well seen, and the spines are more or less broken off. Body-whorl sub-bicarinate,

with a stout diverging pair of spines, or didactyl wing. Other indications are wanting.

Relations and Distribution.—This species seems to be the descendant of the short variety of *Sp. didactyla.* A single specimen was found in the *Sauzei*-bed, or marl with green grains at Oborne.

Genus—Alaria, *Morris and Lycett,* June, 1851.

"*Shell fusiform, turrited; anterior canal straight or curved; lip dilated, digitate or palmate, formed by the prolongation of the last whorl; no posterior canal; no sinus properly so-called on the anterior margin of the lip; columellar margin not callous.*"—Fischer.

The above diagnosis is substantially that of Piette ('Cont. de la Pal. Franç.,' p. 16), who adopted Morris and Lycett's genus with modification. Piette further alludes to the nakedness of the first whorls, which are smooth and convex, and also to the power of developing varices, spurs, and protuberances at various periods of increase, evident traces of rudimentary wings, which appeared usually on the side opposite the actual (definitive) wing.

This very important genus has been variously subdivided into sections, to say nothing of sub-genera, such as *Spinigera* previously described. On the other hand, as already observed, there are not wanting those who fail to see any generic difference between *Alaria* and *Aporrhais* (*Chenopus*). Into these questions I do not feel disposed fully to enter, being on the whole satisfied that the genus *Alaria* may fairly be taken to cover the remainder of the wing-shells of the Inferior Oolite, with possibly one or two exceptions. It would not be difficult for a casuist to prove, almost to demonstration, that the family of the Aporrhaïdæ consists of little more than one genus. Thus Cossmann makes *Malaptera* (in part the old Jurassic *Pterocera*) co-generic with *Aporrhais*, which Gardner says does not differ from *Alaria*, of which *Spinigera*, according to Fischer, is merely a sub-genus. As was urged in the Introduction to this memoir, since the practical acceptance of the doctrine of evolution we no longer worship the fetish implied in such terms as "species," "genus," "family," &c. If no lawyer is able to draft an Act of Parliament through which some other lawyer cannot drive a coach-and-four, how much more applicable is this principle to the diagnosis of shells.

As far as the shell goes we need not, I think, have much difficulty in separating *Alaria* from *Aporrhais* in the majority of cases, since the wing in *Alaria* is barely or, at best, but scantily palmate, and does not envelope more of the spire than the anterior half of the penultimate. The monodactyl *Alariæ* are widely different from

Aporrhais, and, if we except certain obscure forms with no wing attached, the monodactyls seem to have been the earliest Aporrhaïds. Even the didactyl *Alariæ* have the wing but scantily palmate, and not embracing. In the Great Oolite, however, there are forms such as "*Pterocera*" *atractoides*, Desl., where the wing becomes more complex and embracing; and here the resemblance to *Aporrhais* becomes effective. Hence Piette places this species under *Aporrhais*. When we come to the malacology of the subject, attempts at comparison resolve themselves mainly into conjecture, as far as the Jurassic Aporrhaïds are concerned. These may have been the ancestors of part of the Strombidæ as well as of the modern Aporrhaïdæ, and probably differed from both to a certain extent. Piette divided the Jurassic *Alariæ* into five sections, viz. Varicifers, the Monodactyls, the Adactyls, the Longicaudes, and the Hamicaudes. To simplify matters these might be placed under *two grand divisions*. We do not, in this country, appear to have the section "Varicifer" developed, as far as I can understand it; the Monodactyls proper are numerous and important, whilst the Adactyls may owe their wingless appearance to various causes. All these I propose to place under the first grand division, assuming that they either have, or might have, no more than one digitation when there is no evidence of a second. Our *first grand division*, then, is constituted by the *Monodactyls*.

The Longicaudes, which are almost coextensive with the *myurus*-group, and the Hamicaudes, which are almost coextensive with the *trifida*-group, make up the *second grand division*. The shells of both these groups, when mature, develop two digitations on the wing. These are *Didactyls*. There will still remain one or two forms somewhat difficult to place.

It is probably true that more species are made out of these fossils than would be the case if all the specimens could be obtained in a reasonably perfect condition, like the shells, for instance, of existing species of *Aporrhaïs*. But if we were to wait until none but perfect specimens of *Alaria* were accepted, the Jurassic Aporrhaïdæ might as well be left alone. Owing to the number of processes which many of these curious shells possessed, their preservation is rarely complete, and it thus happens that what ought to be recognised as the same species presents such a different aspect under the various conditions under which it is found as to make its recognition very difficult. To avoid error altogether under the circumstances is almost impossible. Too often we have to choose between the Scylla of a doubtful identification and the Charybdis of "species-making."

Thus the first forms described and figured in Pl. IV are wingless, and mostly without the canal-sheath. It becomes necessary to distinguish these in some way, yet such "species" are little more than tentative. The bulk of the species are described with some attempt at grouping.

Division I. The Monodactyls.

27. Alaria arenosa, *Hudleston*, 1884. Plate IV, fig. 1.

1884. Alaria arenosa, *Hudl.* Geol. Mag., dec. iii, vol. i, p. 198 (May), pl. vii, fig. 7.

Description :

Length[1]	20 mm.
Width of body-whorl to length of shell . .	31 : 100.
Approximate spiral angle . . .	25°.

Shell fusiform, turrited. Number of whorls about ten, apical ones unknown. Each whorl has a median carina which is strongly tuberculated. In the upper whorls this tuberculation is extended axially so as almost to reach from suture to suture; but in the last two whorls it is confined to the region of the keels. The whorls are marked with rather strong spiral lines. The body-whorl carries two keels; the upper one is the strongest, and has tubercles very similar to those on the penult; the tuberculations of the lower keel are less strong. The nature of the wing is uncertain, there being no outer lip preserved.

Aperture ?; canal long and moderately curved.

Relations and Distribution.—Some of the peculiarities of the figured specimen are partly due to matrix and condition of the fossil. Piette (*op. cit.*, p. 23) alludes to a variety of *Rostellaria subpunctata*, Münst., figured by Terquem, which, as regards the tuberculations of the lower whorls, may have some resemblance. This was from the *Opalinus*-zone. From *Al. Phillipsii* this species differs in the position of the longitudinal costulæ, in the tuberculated keels of the body-whorl, and in the slightly narrower spiral angle.

Rare in the Dogger Sands (*Opalinus*-zone) this species is interesting as the earliest example of *Alaria* at present known from the Jurassic beds of Yorkshire.

[1] These measurements exclude the canal. Since all *Alariæ* possess a more or less blunt apex, with great convexity of the opening of the spiral angle, the "approximate spiral angle" of this and subsequent measurements is intended to denote the mean angle of the spire without reference to the apical whorls.

28. ALARIA ANGUSTA, sp. nov. Plate IV, fig. 2.

Description:

Length	22 mm.
Width of body-whorl to length of shell . .	30 : 100.
Approximate spiral angle . . .	21°.

Shell fusiform, turrited. Apex blunt. Whorls about ten, prominent and deeply divided by the suture on the principal whorls of the spire; the carina is very nearly median, and the slope of anterior and posterior moieties nearly equal. The longitudinal costæ are well developed, and especially prominent on the keels; they extend almost from suture to suture, but are strongest anteriorly. The spirals are close, undulating, and distinct; about seven fine ones in the posterior half of the whorls, and four or five stouter, and wider apart, below the keels. The last whorl is but slightly ventricose, and has ornaments nearly similar in character to those of the spire, except that the costæ are reduced to tubercles on the keel, and that there is a faint trace of an anterior keel at the base. The canal-sheath is broken off short; other indications wanting.

Relations and Distribution.—Although the specimen from which the above description is taken seems never to have carried a wing, the indications are clearly those of an *Alaria*. The blunt apex, and nearly smooth apical whorls, afford additional evidence in this direction. We may regard it either as an immature shell, or as a species of *Alaria* which had not developed a wing (Adactyl). In many cases the absence of a wing is due to mutilation, but hardly so in this. From the whole of the *hamus*-group it is separated by the ornamented character of the body-whorl, and by considerable differences in the ornaments of the spire and other features. It comes pretty near in many respects to *Alaria arenosa*.

The specimen is unique, and forms part of the Inferior-Oolite collection in the Bristol Museum. I have no note as to the horizon or locality. It is a well preserved spathic fossil in a fawn-coloured limestone, which is not iron-shot.

29. ALARIA ? sp. nov. Plate IV, fig. 3.

There is hardly enough of this fossil remaining to determine its true character. The whorls are very tumid and without much keel. The spiral ornaments are numerous and well cut; the longitudinal costæ are very thick and wide apart, and extend almost from suture to suture. The spiral angle appears to be rather wide.

The last whorl is somewhat inflated, and similarly ornamented. There are indications that possibly another whorl may have been broken off.

In the paucity and thickness of its longitudinals, this form bears some resemblance to *Al. rarispina*, Schlumb. In order to avoid a mistaken identification I would suggest the name CRASSICOSTATA as provisional. A single specimen in the Dogger.

30. ALARIA ? sp. nov. Plate IV, fig. 4.

The spiral angle is about 30°, the length of the specimen about 20 mm., and the number of whorls ten. The whorls of the spire are short and strongly turrited. The sculpture is rich, the longitudinals being numerous and stout, but somewhat irregular; they are mainly confined to the lower part of the whorls, and are extremely nodular at the junctions with the spirals. There is no very salient keel, but the anterior portion of each whorl is marked by three coarse spirals, the uppermost of which serves as a keel, and above this are from three to four fine wavy spirals. The body-whorl is similarly ornamented, but shows rather more irregularity. It shows no sudden increase.

Since the specimen is unique and imperfect as regards the aperture, but little can be said by way of comparison. The rich and nodular character of the sculpture seems to separate it from all forms of the *hamus*-group, and, supposing the shell to be complete in that case the body-whorl is totally different. It was found in the shell-bed of Horton Hill corresponding to the Upper Trigonia-grit (base of *Parkinsoni*-zone), and may be known temporarily as AL. HORTONENSIS.

The *Hamus*-Group.

A very considerable portion of the more strongly turrited and costate *Alariæ* belong to this important group, which is eminently characteristic of the Monodactyl section. They occur principally in the Upper Division of the Inferior Oolite, at least in the South of England. The forms which most nearly resemble the typical specimens of the Bayeux-beds are to be found chiefly in the *Parkinsoni*-zone of South Dorset, but micromorphs and varieties, such as *Al. Phillipsii*, occur in many parts of the Inferior Oolite. Also there are doubtful fossils such as *Al.* "*spinulosa*," which may be immature individuals of *Al. Phillipsii*, or, more probably, of *Al. unicarinata*.

31. Alaria. Variety, or immature form. Plate IV, figs. 5 *a*, 5 *b*.

1884. Alaria Phillipsii, spinulose variety. Hudleston in Geol. Mag., dec. iii, vol. i, p. 149, pl. vi, fig. 5.

Length from 18—25 mm., spiral angle rather over 30°, number of whorls nine. The apex, as is the case with nearly all *Alariæ*, consists of two and a half smooth, rather tumid whorls, but the apical angle as distinct from the spiral angle is only slightly convex. The remaining whorls of the spire are tumid and moderately angular. The longitudinal costæ, at first extending almost from suture to suture, become much shorter on the penultimate and last whorl, where they present the appearance of spinulose nodes. The spirals of the posterior area in each whorl are fine and numerous ; the primary spirals on the anterior area are four, the uppermost one serving as keel. The body-whorl is moderately bicarinate, but the anterior carina probably dies out. The wing is formed on the posterior carina, but no prolonged digitation has been noted.

Aperture wide and triangular; canal straight, as far as known.

Originally it was considered that this form might be a variety of *Al. Phillipsii;* but, if it be not a distinct species, I am disposed to consider that it may be an immature form of *Al. unicarinata*. In order to avoid mistakes it may be distinguished for the present as Al. spinulosa. Rare in the Dogger of Blue Wyke.

32. Alaria hamus, *Deslongchamps*, 1842. Plate IV, figs. 6 *a*, 6 *b*, 6 *c*, 6 *d*; Plate VII, fig. 9.

1842. Rostellaria hamus, *Desl.* Mém. Soc. Linn. Norm., vol. vii, p. 173, pl. ix, figs. 32—36.
1850. Pterocera hamus, *D'Orbigny*. Prod., i, p. 270.
1864. Alaria hamus, *Eud. Desl.* Piette, Cont. de la Pal. Franç., p. 39, pl. v, figs. 1—11, &c., including several varieties.
Non Alaria hamus, *Desl.* In Morris and Lycett, Great-Ool. Moll., p. 16, pl. iii, figs. 2, 2 *a*, 2 *b*.

Bibliography, &c.—The identity of the Normandy fossil with the "*Rostellaria composita*" figured by Phillips (subsequently the *Pterocera Phillipsii* of the Prodrome) was evidently suspected by Deslongchamps. That author describes *Al. hamus* as a common fossil of the "Oolithe ferrugineuse." Only one example was known to him from the Great Oolite. The fact of its rarity in the Great

Oolite is endorsed by Piette and Cossmann. The former figures a variety (*op. cit.* pl. v, figs. 6 and 7) from the Fuller's Earth of Les Clappes, which is characterised by numerous slender longitudinals on each whorl. The same author (*op. cit.*, p. 46) points out the difference between *Al. hamus*, Desl., and the fossil so identified by Morris and Lycett.

Description :

Length of good-sized specimens . .	25 mm.
Width of body-whorl to length of shell . .	40 : 100
Approximate spiral angle . . .	32°

Shell strongly turrited (muricated), fusiform ; apex blunt, but the apical angle only slightly convex, so that the general aspect of the spire is sharp. Number of whorls eleven ; two and a half smooth and convex ; remainder of whorls of spire very angular, the keel being slightly above the middle ; longitudinal costæ strong, regular, and numerous, for the most part sloping from right to left. In the majority of specimens from Burton Bradstock these costæ are confined to the anterior area of the whorl and fail to reach the suture, but in some cases (fig. 6 *a*) they extend across the keel. There are about five spirals above the keel and usually four below, exclusive of the keel. The body-whorl is bicarinate, with the keels plain, and the spiral ornamentation fainter in most cases ; the posterior keel carries two spinous lumps, one situate half a turn above the wing and the other mid-way between these points.

The aperture is triangular to trapezoidal. The wing is constituted by the continuation of the posterior or principal keel, and consists of one stout digitation proceeding for some distance at right angles to the axis of the shell and suddenly curving upwards, somewhat after the fashion of a hook (the sharpness of this curve not sufficiently shown in fig. 6 *c*) ; see also Plate VII, fig. 9. The wing scarcely overlaps the base of the penultimate. The delicate spiral ornamentation is continued on the wing, base, and canal-sheath, being faintly decussated by fine longitudinal lines. Canal broad, moderately long, and curved anteriorly, though not to any great degree.

Relations and Distribution.—As the type of the Monodactyls *Alaria hamus* constitutes a standard of comparison both for varieties and species. The Dorsetshire specimens most nearly approach Deslongchamps' fig. 32. In the Normandy specimens which I have seen the wing appears to overlap the base of the penultimate somewhat more than in our English examples, and possibly the hook-like curve at the termination of the digitation is sharper, and the digitation itself shorter in the Normandy specimens. The individual figured (Pl. VII, fig. 9) is an unusually fine example.

This species is most abundant in the *Parkinsoni*-zone of South Dorset, and especially at Burton Bradstock, whence nearly all our best specimens are obtained

—mostly from P_1 (page 31). Specimens showing any of the processes (6 *c*, 6 *d*) are rare. The specimen 6 *d* differs somewhat from all the others, and approaches the var. *Phillipsii* in some respects, and still more reminds me of the form provisionally described as *Al. spinulosa*. I think that *Al. hamus*, as defined above, is mainly confined to the upper division of the Inferior Oolite, at any rate in Dorsetshire. Elsewhere in England, except perhaps at Dundry, it appears to be represented either by the variety *Phillipsii*, or else by dwarf forms, like those to which I now direct attention.

33. Dwarf varieties of Alaria hamus. Plate IV, figs. 7 *a*, 7 *b*, 7 *c*.

Specimens from the *Parkinsoni*-zone of Notgrove (fig. 7 *a*) and from the *Parkinsoni*-zone of Horton Hill (Upper Trigonia-grit) are fairly similar. The dwarfing extends to all the whorls, the whole shell is proportionally smaller, and the large spirals on the anterior portions of the whorls are always *three* in number. The keel of the body-whorl possesses the spinous lumps characteristic of *Al. hamus*, but they are better shown in specimens from Horton Hill than in the more slender ones from Notgrove, which might indeed be regarded with equal justice as dwarfs of the variety *Phillipsii.*

The specimen from Horton Hill (fig. 7 *b*) is sufficiently well preserved to show that it was possessed of a wing and "tail" in all respects, except as to size, identical with *Al. hamus.* The evidence of a wing in the case of the Notgrove specimens is less clear, but the plain and strongly-keeled body-whorls show that the specimens are mature shells.

The specimen (fig 7 *a*) from the Gryphite-grit of the neighbourhood of Stroud presents other differences. The shell is shorter in proportion to its width, and seems to have matured earlier; the whorls are strongly muricated. In this specimen the three spirals which occupy the anterior portion of the whorls of the spire are so conspicuous that, if a trivial name be required, I would suggest that of TRICINCTA.

The specimen (fig. 11), also from the Gryphite-grit, is most probably an immature form of *Al. Phillipsii.* Such forms are not uncommon in the Scarborough Limestone, and these of course are referred to *Al. Phillipsii* in default of better evidence.

It should be noted that, while the full-grown and typical forms of *Al. hamus* occur in the Dorset district, these dwarfed varieties seem to take its place in the Cotteswolds.

34. ALARIA HAMUS, Desl., var. PHILLIPSII, D'Orbigny, 1850. Plate IV, figs. 8 *a*, 8 *b*, 8 *c*.

1829. ROSTELLARIA COMPOSITA, *Sow.* Phillips, G. Y., pp. 124, 129, 165, pl. ix, fig. 28.
1850. PTEROCERA PHILLIPSII, *D'Orbigny.* Prod., i, p. 270.
1853. ALARIA PHILLIPSII, *D'Orb.* Morris and Lycett, Great-Ool. Moll., p. 111, pl. xv, figs. 15, 15 *a*.
1854. — — — Morris, Catalogue, p. 234.
1867. — — *D'Orb* = AL. HAMUS, *Desl.* Laube, Gast. von Balin, p. 23.
1884. — HAMUS, *Desl.*, var. PHILLIPSII, *D'Orb.* Hudleston, Geol. Mag., dec. iii, vol. i, p. 145, pl. vi, figs. 3 and 4.

Bibliography, &c.—It is noticeable that Morris regarded *Al. hamus* as a species of the Great Oolite only, and *Al. Phillipsii* as a species confined to the Inferior Oolite in England (Scarborough Limestone, &c.). It has already been shown that Morris and Lycett were incorrect in their identification of Deslongchamps' species, which can scarcely be said to occur in the Great Oolite in England. But it is evident that Morris, judging from the localities quoted in his " Catalogue," regarded *Al. Phillipsii* and the true *Al. hamus* as the same species. Laube takes the same view, but gives no figure.

If we could obtain perfect specimens of each, the point might be settled. Up to the present time I have never seen a Yorkshire specimen with the wing-digitation preserved. In fact I have never seen from any locality in England a specimen of the variety *Phillipsii* with the digitation.

Lately an unusually good specimen (fig. 8 *a*) was obtained from the Scarborough Limestone.

Description.—The points in which this differs from the Dorsetshire *Al. hamus* are that the spire is more slender, the costulæ are smaller, and the whorls are less boldly muricated; the aperture is subtriangular as in *Al. hamus*, and I think there are traces of the spinous swellings on the upper keel of the body-whorl. Imperfect specimens from the Dogger (fig. 8 *b*) and from the Millipore-bed (fig. 8 *c*) seem to bear out this view.

Relations and Distribution.—But little more need be said about the relations of this very doubtful species or variety. Most specimens of *Alaria* from the Inferior Oolite, which possess a moderately thin spire with longitudinal costulæ arranged in a circlet anteriorly on the whorls, and a plain bicarinate body-whorl are likely to be thus referred. The type is a very general one throughout the Oolites, and

is well exemplified in "*Rostellaria*" *composita*, Sow., a lower Oxfordian fossil, *Alaria seminuda*, Héb. and Desl., and probably others.

35. Alaria hamus, *Desl.*, var. nodosa. Plate IV, fig. 9.

A single specimen, said to come from Stoford, in the Buckman Collection, presents some curious analogies with, and yet some marked differences from, *Al. hamus*. It is a stouter and larger shell than the average of South-Dorset specimens. Number of whorls ten to eleven; not only are the apical whorls smooth and without ornament, but this peculiarity extends to the subapical whorls, so that the turrited character characteristic of the *hamus*-group is not developed until much later. The longitudinals are extremely thick and nodose. The wing overlaps the lower half of the penultimate, a feature not preserved in the Burton Bradstock specimens; there seems also to have been an anterior spine on the keel of the body-whorl instead of a mere spinous swelling.

36. Alaria pinguis, sp. nov. Plate IV, fig. 10; and Plate VII. fig. 11.

Description.—Since the available specimens are probably incomplete, dimensions cannot be given, but the spiral angle is about 45°. Spire wide-angled and conoidal, and consisting of eight whorls; the apical whorls, as usual, plain; subapical whorls convex and either plain or spirally striated; the anterior whorls possess coarse longitudinal tuberculation in addition to the spiral ornaments. Body-whorl bicarinate, keels plain or nearly so.

Relations and Distribution.—Through the var *nodosa* there seems to be some connection between these shells and the regular *Al. hamus*. Yet, omitting that possible intermediary, the differences are so great as to warrant a somewhat stronger distinction. Since none of the processes are known, the species must be regarded as tentative and incomplete.

Rare in the *Parkinsoni*-zone of Dorset. The specimen, Pl. IV, fig. 10, is from Stoford, horizon unknown; the specimen, Pl. VII, fig. 11, is from P_1, Vitney Cross.

37. Alaria: *Cf.* rarispina, *Schlumberger*, 1864. Plate IV, fig. 12.

1864. Alaria rarispina, *Schlumberger*. Bull. Soc. Linn. Norm., vol. ix, p. 225, pl. vi, figs. 7—9.
1867. — — — Piette, Continuat. Pal. Franç., p. 100, pl. xx, figs. 1—3.

This specimen sufficiently resembles the description given by Piette to warrant its comparison. The spire has an angle of about 26°; whorls angular, keel about one third distant from the posterior suture; costæ very wide apart, but extending almost from suture to suture; spirals fine and wavy. Part of the penultimate is devoid of costæ. Body-whorl scarcely bicarinate, and showing traces of a varix or spine on the keel.

Piette observes that Schlumberger's shell is very distinct from all other hamiform species; it was described from a single specimen in the *Sowerbyi-Murchisonæ*-zone of the Meurthe.

The specimen here figured is probably from the *Sowerbyi*-bed in Dorsetshire. It is certainly a more angular shell than the one figured by Piette, which, as regards the spire only, has more resemblance to the form (Pl. IV, 3) provisionally named "*crassicostata*." A specimen lately acquired for the York Museum, in a similar matrix, shows that the wing-digitation is more produced and less sharply curved than in *Al. hamus*. Rare.

The following species, viz. *Al. unicarinata*, *Al. unicornis*, and *Al. unicornis*, var., constitute a subgroup related to *Al. hamus*, but distinguished in possessing a somewhat different digitation, in the effete character of the anterior keels on the body-whorl, and especially in the possession of powerful curved spines on the keel instead of mere spinous protuberances. They belong also, as it seems to me, to a lower horizon. It may be, indeed, that these are only varieties of one species.

38. Alaria unicarinata, *Hudleston*, 1884. Plate IV, figs. 13 *a*, 13 *b*, 13 *c*.

1884. Alaria unicarinata, *Hudl.* Geol. Mag., dec. iii, vol. i, p. 149, pl. vi, figs. 1, 2, 2 *a*.

Bibliography, &c.—Two specimens of *Alaria*, one in the York Museum, the other in the British Museum, seemed to me sufficiently distinct from *Al. Phillipsii*, as recognised by Morris and Lycett, to warrant distinction. Since then I have ascertained that this is the more usual form in the Dogger. It is just possible

that Phillips' figure may have been meant for this one; for, although figured in the plate showing the Scarborough-Limestone fossils it has somewhat the look of a Dogger specimen.

Description :

Length	26 mm.
Width of body-whorl to length of shell . .	38 : 100
Approximate spiral angle . . .	31°

The spire is mainly on the type of *Alaria hamus*, but there is considerable variation in the several specimens; the whorls are more angular in some (fig. 13 *a*, fig. 13 *c*), more rounded in others (fig. 13 *b*); the position of the keel in the whorls of the spire also varies, being central in figs. 13 *a* and 13 *b*, and situate in the posterior third in fig. 13 *c*. The longitudinal costæ likewise show considerable difference. Part of this apparent difference is due to mal-preservation (fig. 13 *a*). The body-whorl is without costæ, and the anterior keel is so much aborted that the species is practically unicarinate. The keel gives birth to a very large spine a quarter of a turn above the base of the wing, and to another spine a quarter of a turn farther back, the latter being exactly opposite the wing.

The aperture is triangular, the wing being pretty full for a Monodactyl, and terminating in a stout digitation, the exact nature of which has not been ascertained. Canal straight at first, but the exact termination unknown.

Relations and Distribution.—The affinities of *Al. unicarinata* have already been partially indicated; when mere fragments of the spire alone are preserved, as is too often the case, it cannot well be distinguished from the mass of costated and turrited *Alariæ*. Not uncommon in the Yorkshire Dogger; it probably occurs in the Duston ironstone.

N.B.—It should be observed that fig. 13 *a* is not a back view, but just midway between a back view and a front view. The fracture on the keel represents the posterior spine broken off; the anterior spine is seen on the left.

39. Alaria unicornis, *Lycett*, 1853. Plate V, fig. 1.

1853. Rostellaria unicornis, *Lycett*. Proc. Cotteswold Nat. Field Club, vol. i, p. 80.

Description.—"Spire lengthened, composed of many whorls; whorls costated, the costæ terminating in knobs on their upper portions; costæ ten in a volution, indented by five encircling striæ, last whorl smooth with a single prominent carina, having an acute and elevated spine about a quarter the circumference posteriorly from the outer lip; the wing single, rounded, curved, slender, and produced; caudal extremity moderately long."—Lycett.

The specimen figured has a length of 26 mm. (exclusive of the fragment of the canal-sheath), and a spiral angle of about 30°.

Relations and Distribution.—It is only piecemeal, as it were, that we can hope to work out the true relations of the Jurassic *Alariæ*. Available specimens are generally wanting in some feature of importance. In the present case, if we were sure that *Al. unicornis* possessed a second spine, opposite the wing, this feature would serve still more closely to connect it with *Al. unicarinata*, notwithstanding certain differences in the spire which are increased by difference of matrix. Again, we are not certain of the true character of the digitation of *Al. unicarinata.*

Very rare in the Oolite-Marl of the Cotteswolds.

40. ALARIA : *Cf.* UNICORNIS, *Lycett.* Plate V, figs. 7 *a*, 7 *b*.

Description :

Length	26 mm.
Width of body-whorl to height of shell . .	42 : 100.
Spiral angle	28°.

Shell turrited, fusiform, elongate. Number of whorls about ten, excluding the apicals; the whorls of the spire are very angular, and the keel placed rather far back, so as to make the anterior area twice as long as the posterior area. This peculiarity is less strong on the penultimate than on the other whorls of the spire. The costæ are regular, very straight, and rather strongly marked, though becoming less well-developed in the anterior whorls. The spirals are fine and crowded posteally, much coarser, about four in number, below the keel. The body-whorl is entirely without costæ, though marked by longitudinal striæ. It is practically unicarinate, since the lower keel becomes effete before reaching the margin. The keel is very salient and carries two large spines :—*a*, the anterior spine, a quarter of a turn above the wing; *p*, the posterior spine, a quarter of a turn higher up, *i. e.* opposite the wing.

The aperture is rudely triangular, the wing consists of one digitation, which is stout at the base, but has not been observed further. Canal staight, as far as observed.

These shells occur rarely towards the junction of the *Sowerbyi*-bed and the paving-stone bed at Bradford Abbas, and may be regarded as belonging to the *Murchisonæ*-zone. If a varietal name is required I would suggest that of BRADFORDIENSIS.

41. Alaria fusca, sp. nov. Plate V, fig. 3.

Description:

Approximate length	26 mm.
Width of body-whorl to length of shell . .	48 : 100.
Spiral angle	38°.

Shell turrited, subelongate, apex blunt. Number of whorls about 10; the two apicals rounded and without ornament; whorls of the spire tumid and subangular, keel median and becoming very prominent in the anterior whorls. Longitudinal costæ numerous, close, slightly curved, and extending nearly from suture to suture, being equally well-developed on the posterior as on the anterior area; spiral striæ regular, numerous, and nearly uniform; sutures distinct and bordered by a slightly raised rim. Body-whorl without costæ; posterior keel enormously developed, anterior keel barely perceptible.

Wing single, with a deep and strong digitation, extending at right angles to the axis of the spire for about three-fourths the length of the spire, where it forms a very thick elbow, and then turns up in the shape of a short hook; the digitation is finely marked by lines in continuation of the spiral ornament of the shell. Other indications wanting.

Relations and Distribution.—Differs from *Al. hamus* in the shape of the whorls, which are less mural, in the more median position of the keel, and in the fact that the costæ extend nearly from suture to suture. In this species the posterior keel is more salient, and the anterior keel less developed. The length of the digitation and its great thickness at the elbow are also differences, so far as we can judge, from the few specimens which have these processes preserved. On the other hand, the shell is by no means wanting in a general resemblance to *Al. Dundryensis*, though unfortunately we are ignorant of the character of the wing in Mr. Tawney's species.

Alaria fusca is extremely rare in the *Cadomensis*-bed at Oborne (upper part of the *Humphriesianus*-zone).

42. Alaria. Species or variety. Plate V, fig. 4.

There is hardly justification for burdening our lists with a fresh name in the present instance. This may possibly be the Dorsetshire representative of *Al. Dundryensis*, to which it bears considerable resemblance in the character of the

spire and its ornaments. The spire also has many points of resemblance to that of *Al. fusca*, but the digitation is more slender, and less abrupt in its upward curve.

A single specimen from the Inferior Oolite of North Dorset, horizon and locality unknown. As a mere name of convenience I would suggest that of AL. ALIENIGENA.

43. ALARIA DUNDRYENSIS, *Tawney*, 1873. Pl. V, fig. 2. *Type refigured.*

1873. ALARIA DUNDRYENSIS, *Tawney*. Dundry Gasteropoda, p. 12, pl. i, fig. 5.

Description.—" Shell fusiform, elongate. Whorls seven to nine, angular; the keel not quite in the middle of the whorl, but inferior thereto; on the keel is a series of tubercles, probably twelve to fourteen on a whorl, which do not form costæ in the [anterior] whorls, *i. e.* the last, but are vertically compressed; the surface shows faint [longitudinal] lines; there are fine [spiral] lines, which are stronger near the suture."—TAWNEY.

Description:

Length	30 mm.
Width of body-whorl to height of shell . .	44 : 100.
Spiral angle	36°.

The type is one of those shells preserved in crystalline calcite, where the ornamentation has probably undergone considerable modification, and this especially affects the length of the costæ. The body-whorl is almost unicarinate and without costæ; no spines are preserved, though there is good reason to suppose that a very prominent one existed a quarter of a turn above the wing. The base of the wing (which doubtless was monodactyl) is ornamented by fine cross-hatching, and it has a slight tendency to overlap the anterior portion of the penultimate. Other indications wanting.

Relations and Distribution.—The sub-median position of the keel, and its marked prominence, serve to separate this species from all members of the *hamus*-group; it is also much more unicarinate, and probably possessed a digitation of a very different character, which may have resembled that of *Al. fusca*, but which more probably resembled that of *Al. Roubaleti*, var. *Dorsetensis*, next to be described.

The type-specimen is from the Inferior Oolite of Dundry, and is the only one known to me which presents any describable features.

44. ALARIA ROUBALETI, *Schlumberger*, 1864, var. DORSETENSIS. Plate V, figs. 5 *a*, 5 *b*, 5 *c*, 5 *d*, 5 *e*, 5 *f*; and Plate VII, fig. 10.

1864.	ALARIA ROUBALETI, *Schlumberger*.		Bull. Soc. Linn. Norm., vol. ix, p. 223, pl. vi, figs. 4—6.
1867.	—	—	Piette, Cont. de la Pal. Franç., p. 102, pl. xx, figs. 4—8.

Bibliography, &c.—The typical *Alaria Roubaleti*, Schlumb., is said to occur in the Department of the Meurthe (Lorraine), in a bed characterised by *Am. Sowerbyi* and *Am. cycloides*. The Dorsetshire fossil now under consideration is eminently characteristic of the so-called *Sowerbyi*-bed of Bradford Abbas, where it is rather abundant, and of course subject to considerable variety. In collections it is generally labelled *Al. Dundryensis*.

Description:

Length of large specimen . . .	32 mm.
Width of body-whorl to height of shell . .	44 : 100.
Spiral angle	36°.

Shell turrited, fusiform, subconical; apex very blunt. Whorls about ten; apicals globose and smooth, succeeding whorls convex, and becoming angular owing to the development of a strong keel, which is rather below the middle. The longitudinal costæ of the earlier whorls of the spire are very numerous, curved, and extend from the posterior almost to the anterior suture. These costæ disappear entirely on the posterior area of the ante-penultimate, and are only traceable as very faintly-cut serrations at wide intervals on the penultimate. The spiral lines are fine and very numerous; in the posterior areas they are closely set and of nearly equal strength; anteriorly the spiral lines are more irregular, so that a shallow sulcus is formed between each keel and the anterior suture.

In immature specimens, which have not developed a wing (fig. 5 *e*), the last whorl is strongly bicarinate, but the next half-turn, which developes the wing, presents a body-whorl with the anterior keel greatly diminishing in importance as it approaches the margin. In mature specimens the body-whorl is full, entirely without longitudinal ornament, and only slightly bicarinate; the spiral lines are fine and very numerous, and slightly cross-hatched by radial lines of growth. The posterior keel carries two very powerful spinous processes (see basal views of figs. 5 *a* and 5 *c*); the anterior spine, *a*, is a quarter of a turn above the wing; the posterior spine, *p*, is a quarter of a turn farther back, and, consequently, opposite the wing; both spines curve forwards.

The aperture (fig. 5 *a*) is widely triangular; the wing is constituted by the prolongation of the principal keel, and consists of one long and moderately stout digitation, which attains a length equal to the height of the spire before gradually curving backwards with a wide sweep towards its terminal point (see Pl. VII, fig. 10). Delicate lines, in continuation of the spirals, slightly cross-hatched by longitudinal lines, ornament the wing and digitation, and, in a less degree, the wing and canal-sheath. The canal is moderately wide, and extremely long, tapering gradually to a point; it has a slight anterior curve.

Relations and Distribution—It is probable that, in the presence of more perfect specimens of *Al. Roubaleti* and *Al. Dundryensis*, the differences which now seem to separate the var. *Dorsetensis* from both the other forms might be bridged over. At present we must be content to keep them apart, bearing in mind also that, in the type specimen of *Al. Dundryensis,* the processes of whatsoever nature, with the exception of the canal-sheath, are altogether wanting. Even granting that *Al. Dundryensis* was possessed of two spines on the keel, of which no mention is made in the diagnosis, there still remains a very considerable difference in the ornamentation of the spire, which is so very plain in the lower whorls of *Al. Dorsetensis.* On the other hand, the spire of Schlumberger's species has a very great resemblance to the Dorset fossil, but the latter differs in the development of two very important curving spines, which in *Al. Roubaleti* appear as mere spinous swellings. Moreover, we really know very little regarding the other processes of *Al. Roubaleti.*

Owing to the comparative abundance of *Al. Dorsetensis*, it is possible, from one specimen or another, to obtain a tolerably complete notion of the original shell, which must be accepted as typical of the group to which it belongs. From the *unicarinata*-group, which shares with it the possession of two similar and similarly situated spines, it differs entirely in the character of the spire. From the *hamus*-group it differs, still more widely, in the length and slight curvature of the "tail," and also in the length and moderate curvature of the wing-digitation, as well as in the character of the spire (see Pl. VII, figs. 9 and 10, where the two forms are well contrasted).

45. Alaria Roubaleti, *Schlumberger:* another variety. Plate V, fig. 6.

Spiral angle 28°. This form is at once distinguished from the numerous specimens of the far commoner *Al. Dorsetensis* by the comparative narrowness of the spiral angle and the greater delicacy of the ornamentation. A careful examination of the figured specimen renders it almost certain that it possessed the two spines characteristic of *Al. Dorsetensis.*

The aperture is triangular, and produced in a long and slender canal, somewhat more curved than in the preceding. In the figured specimen the callus of the inner lip extends to the upper keel.

Rare in the *concavus*- or *Sowerbyi*-bed of Halfway House. If a temporary name is required, I would distinguish this form as Alaria dimidiata.

46. Alaria pseudo-armata, *Hudleston*, 1884. Plate V, fig. 8.

1884. Alaria pseudo-armata, *Hudleston*. Geol. Mag., dec. iii, vol. i, p. 150, pl. vi, figs. 6 and 6 *a*.

Description :

Length	. 26 mm.
Width of last whorl to length of shell .	. 48 : 100.
Spiral angle . . .	. 34°.

Shell strongly turrited. Whorls about ten; those below the apicals are extremely angular, the dividing carina occurs about two-thirds down—a feature which is very marked in the penultimate. Each whorl has about eight short, tuberculated costulæ, which are straight and not developed in the anterior areas; spiral ornaments uncertain, apparently irregular. Body-whorl is largely developed, very angular, and without costæ. It carries a large median keel which supported one or two immense spines. Other indications wanting.

Relations and Distribution.—The peculiar character of the spire will serve to distinguish this species from any other *Alaria* in the Inferior Oolite. It evidently belongs to the section of unicarinate monodactyls, which carried powerful spines on the keel of the body-whorl. It may also have some relationship to *Al. armata*, M. and L., though that species is a difficult one to understand.

Extremely rare in the Yorkshire Dogger.

47. Alaria Lotharingica, *Schlumberger*, 1864. Plate V, fig. 9.

1864. Alaria Lotharingica, *Schlumb.* Bull. Soc. Linn. Norm., vol. ix, p. 222, pl. vi, figs. 1—3.
1867. — — — Piette, Cont. de la Pal. Franç., p. 105, pl. xxi.
1873. — — — Tawney, Dundry Gasteropoda, p. 14.

Description :

Probable length	40 mm.
Width of last whorl to length of shell .	25 : 100.
Spiral angle	14°.

Shell extremely elongate, slightly turrited. Whorls about ten (six visible in the figured specimen), convex, and scarcely angular, since the very slight keel or shoulder is close to the anterior suture. The longitudinals consist of regular and very straight ribs of considerable thickness, extending nearly from suture to suture; these decussate with a system of rather prominent spirals, which are continued in the base of the shell. The body-whorl shows a slight increase beyond the regular spiral angle, owing to the development of a strong median keel.

Piette observes that this keel, which becomes spinous on the side opposite the wing, forms in its prolongation a thick digitation bent upon itself, which twists towards the point of the spire.

Relations and Distribution.—This is a Monodactyl of peculiar form, which seems almost to stand by itself, or at least to have no near relations, except perhaps in some degree to the species next described. Piette describes several varieties.

It is said to be common in the zones of *Am. Sowerbyi* and *Am. Murchisonæ*, in the Department of the Meurthe. The Dundry specimen now figured, originally described by Tawney, is at present unique as a British example of this species.

48. Alaria prælonga, sp. nov. Plate V, fig. 10.

Description :

Probable length	46 mm.
Width of body-whorl to length of shell .	30 : 100.
Spiral angle	17°.

Shell extremely elongate, turrited. Whorls ten or eleven in number, and moderately angular, the keel being situate rather more than one-third the distance from the anterior suture. The longitudinals are mainly confined to the anterior area of the whorls, and consist of very straight stout costæ, decussating with spirals which are more or less obliterated in the available specimens. In the penultimate the longitudinals fail entirely, the keel being plain and nearly median. There is a sharp rise of the keel in the body-whorl, which keel is also plain with indications of a spinous projection on the side opposite the outer lip; the position of the keel is irregular.

The aperture is triangular, and there is a considerable callous deposit on the columellar side. The indications of a wing and canal are not distinct.

Relations and Distribution.—Whether this curious species is a Monodactyl or an Adactyl cannot at present be decided. The condition of the available specimens is such as to lead to very grave suspicions. It is probably related to *Al. Lotharingica.*

Very rare in the *Murchisonæ*-zone of Halfway House.

We may fairly refer to these narrow-angled and elongate Alarias as the *Lotharingica*-group; and with this group terminates Section I, or the Monodactyls in the wider acceptation of the term.

Division II. The Didactyls.

Section 1.—*Imperfectly Didactyl.*

49. Alaria Doublieri, *D'Orbigny.* Plate V, fig. 11; Plate VI, figs 1 *a*, 1 *b*, 1 *c*.

1850. Pterocera Doublieri, *D'Orbigny.* Prod. i, p. 270.
1866. Alaria — — Piette, Cont. de la Pal. Franç., p. 54, pl. vi, fig. 1; pl. vii, fig. 1.

Bibliography, &c.—D'Orbigny observes that this species is near to *Pterocera* (*Chenopus*) *Philippi*, K. and D., referred to by Piette as *Alaria bicarinata.* The type is said to have been derived from the Department of the Var. The specimens described and figured by Piette were so imperfect as to leave his determinations somewhat incomplete. But the semi-digitation, so to say, of the anterior portion of the wing, in addition to a considerable resemblance in the spire, helps to connect D'Orbigny's species with certain specimens found in the Inferior Oolite of Dorsetshire, which can scarcely all be referred to one species. These, however, for the present may be treated as varieties.

Var. A. (Plate VI, figs. 1 *a*, 1 *b*, 1 *c*).

Description.—Length of a full-grown specimen about 30 mm.; approximate spiral angle 36.° Shell conoidal, fusiform, apex of spire very blunt. Number of whorls about ten. The first five or six whorls[1] are convex and nearly smooth, or only marked by fine spiral lines; next succeeds a whorl with fine spiral lines and a faint submedian keel. The three remaining whorls of the spire, in addition to the fine spiral lines, develop a strong and rather blunt median keel, which at once

[1] None of the available specimens of this variety exhibit the extreme apicals in such a condition as to afford the means for a thoroughly accurate description.

makes the whorls angular instead of convex (see Pl. VI, fig. 1 *b*, and enlargement, where the successive stages of growth are very well shown). In the penultimate and antepenultimate the anterior area is excavated, and exposes a rim above the suture, prefiguring, as it were, the anterior keel. The body-whorl carries a prominent posterior keel in the middle, which gives rise to a stout digitation; this is connected by a slight palmation of the wing with a very short process, arising from the anterior keel, which has the appearance of an attempt to form an anterior digitation. The termination of the principal digitation is unknown. The spiral lines or striæ are continued on the wing and base of the shell, and slightly cross-hatched with axial lines. The posterior keel carries a short curved spine, half a turn above (*i. e.* opposite) the base of the wing; the existence of a spine between this one and the wing is not indicated in any of the specimens hitherto available.

The aperture is triangular to trapezoidal; the incrustation on the columellar side extended to the edge of the principal keel; canal rather narrow and nearly straight, so far as has been observed.

Relations and Distribution.—The specimens on which the above description is based are all from the Inferior Oolite of North Dorset, but the exact horizon is not known. In two of them the anterior "semidigitation" is well preserved. If we were desirous of obtaining any evidence as to the existence of an apparent link between the Monodactyls and the Didactyls these fossils seem to afford us a clue. The character of the spire, however, points to the latter rather than to the former, and the general affinities are perhaps almost as much with the *myurus*-group as with the *trifida*-group (*Chenopus Philippi, &c.*).

Though mainly confined to North Dorset there are some badly preserved specimens of *Alaria* from Dundry in the Bristol Museum, which might probably be classed under one or other of the varieties of *Al. Doublieri.*

Var. B. (Pl. V, fig. 11.)

A single specimen from the *Cadomensis*-bed of Oborne presents us with a spire in a very perfect condition but without processes of any kind. The spiral angle is nearly 40°, and very convex towards the apex. The apicals consist of two and a half whorls, perfectly smooth and convex; next succeeds a whorl convex and with regular longitudinal costæ, extending from suture to suture, and fine spiral striæ; the next whorl, though still very convex, developes a slight keel, whilst very fine spiral lines decussate with costæ which are more numerous and finer than in the preceding whorl. Remainder of the spire and body-whorl similar to those of Var. A.

It may be that the apical conditions of this specimen are really the same as those of Var. A. There are no certain signs of a spine but rather of a spinous swelling. On the whole there is probably no real difference between Var. A and Var. B, other than what may be due to the preservation of different features in each case.

50. Alaria: species or variety. (Pl. VI, fig. 2.)

Differs from the forms already described in the much coarser ornamentation of the higher whorls; the spiral lines, too, are stronger and wider apart and the keel more salient; the spiral angle is narrower, and there was an immense spine about one-quarter of a turn above the base of the chief digitation.

Founded on an imperfect specimen said to come from the *Humphriesianus*-zone of Dorset. This I think may prove to be a distinct species. It possibly belongs to the section of *Alaria* now under consideration, or it may be truly Didactyl, since the character of the penultimate and antepenultimate is greatly that of the *trifida*-group. Alaria dubia might do as a trivial name.

Section 2.—*Perfectly Didactyl.*

a. The *Myurus*-group = the "Longicaudes" of Piette.

51. Alaria sublævigata, sp. nov. Plate VI, figs. 3 *a*, 3 *b*; 3′ *a*, 3′ *b*.

Cf. Alaria myurus, *Deslongchamps*, narrow variety. Hudleston, Geol. Mag., dec. iii, vol. i, p. 196, pl. vii, fig. 6.

Description:

Length	28 mm.
Width of body-whorl to height of shell	44 : 100
Spiral angle.	34°

The points in which this species or variety differs from *Al. myurus*, Desl., are:—the general form is slightly more elongate in the majority of specimens, the whorls are less tumid, and the position of the spine on the posterior keel is differently placed; in this case being nearly three-quarters of a turn above the commencement of the wing; the anterior keel is also better defined on the side of the columella; the aperture is somewhat more triangular.

Relations and Distribution.—In some respects this species has more resemblance to *Al. lævigata*, M. and L., but the position of the principal spine, the comparative straightness of the canal, the keel in the penultimate, and the well-developed spiral lines, should, if Piette's description is to be accepted, distinguish *Al. sublævigata* from the Great-Oolite species.

Occurs sparingly in the Inferior Oolite of North Dorset, and chiefly in the *Sowerbyi-* or *concavus*-bed. The variety shown in figs. 3′ *a* and 3′ *b* from Bradford Abbas has a smooth outline, and but for the position of the spine might almost be referred to *Al. myurus*. The specimen, 3 *b*, is from the Yorkshire Dogger.

52. Alaria myurus, *Deslongchamps*, 1842. Plate VI, figs 4 *a*, 4 *b*, 4 *c*.

1842. Rostellaria myurus, *Deslongchamps*. Mém. Soc. Linn. Norm., vol. vii, p. 176, pl. ix, figs. 23—25.
1850. Pterocera — *D'Orbigny*. Prod., i, p. 270.
1864. Alaria myurus, *Eud. Desl.* Piette, Cont. de la Pal. Franç., p. 30, pl. ii, figs. 8—11, and pl. vi, figs. 11, 12.
? — — *Desl.* Lycett, Suppl., p. 122, pl. xli, fig. 13.
? — — — Tawney, Dundry Gasteropoda, p. 11.

Bibliography, &c.—Deslongchamps' species is a fossil of the "Oolithe ferrugineuse" (Calvados), and belongs consequently to the Upper Division of the Inferior Oolite. It was said to be rare, but Piette qualifies this by stating that it is tolerably numerous. *Al. myurus* is not quoted in Morris's Catalogue of British fossils. Mr. Tawney drew attention to some imperfect specimens from Dundry; none of these show very characteristic features.

The value of the difference between *Al. myurus*, Desl., and *Al. lævigata*, M. and L., is a question that has been much debated. In 1884 ('Geol. Mag.,' p. 196) I pointed out that the absence of striæ, on which alone Morris and Lycett based their distinction, was, under the circumstances, of no value whatever. This was written before I had read Lycett's note in the Supplement, where, in consequence of his having discovered striæ in *Al. lævigata*, he withdrew it as a distinct species. Laube ('Gast. von Balin,' p. 24) endorses this union of *Al. lævigata* and *Al. myurus*. Piette, on the other hand, says that, although *Al. myurus* is near to *Al. lævigata*, it has the spire more ventricose and less elongate, it is striated almost throughout and the penultimate is subangular. Cossmann ('L'Étage Bathonien en France,' p. 164), alluding to the remarks of Lycett in the Supplement, and of Laube, is disposed to agree with Piette, and separates them as distinct species. On the whole it seems to me that the differences are slight, but apparently constant according to horizon; hence, although the original difference noted by the authors of

Al. lævigata is admitted to be non-existent, there seem some grounds for distinction in other respects.

Description :

Length of largest specimen . .	35 mm.
Width of body-whorl to height of shell .	54 : 100.
Spiral angle	40.°

Shell fusiform, elongate, about ten whorls; apicals unknown. The spire is composed mainly of about five very convex whorls, which are covered by fine spiral bands separated by regular furrows. Towards the centre of the penultimate one of these spiral bands becomes conspicuous and forms a slight keel. The body-whorl is bicarinated; the posterior keel, more salient than the other, gives rise to a strong spine a quarter of a turn above the base of the wing. The spiral ornamentation is very marked between the keels and in the base of the shell; as many as a dozen spiral bands may be counted between the keels, some of which are continued on the respective digitations; a system of finer lines intervenes. The wing consists chiefly of two long, diverging digitations, which are subtriangular in section. Piette says that the posterior digitation forms the arc of a circle of which the centre is situated towards the point of the spire.

The aperture is trapezoidal with a considerable callus on the columella; the canal is said to be long and almost straight, being barely curved at its extremity.

Relations and Distribution.—The relations of this, the type species, to such forms as *Al. lævigata* and *Al. sublævigata* have been already indicated. The possibility of some of these latter being immature specimens of *Al. myurus* has been intimated. It is very rare in the Inferior Oolite of England. One of the figured specimens (4 *a*) is from Dundry, and is by far the finest ever seen by me from English beds. Figs. 4 *b* and 4 *c* represent specimens from the *clypeus*-grit of the Stroud district, which already present some slight differences. The specimen fig. 4 *c* in many respects resembles one described by me (' Geol. Mag.' 1884, p. 197) from the Cornbrash of Scarborough as *Al. myurus* var. *teres.*

Some might prefer to regard *Al. lævigata, sublævigata,* &c., merely as varieties of Deslongchamps' species.

b. The *Trifida*-group = the " Hamicaudes " of Piette.

It is by no means easy to decide whether to admit as species the numerous forms of this widely spread group, which have received names from various authors. That its members vary considerably as to size and proportions in the same series of beds may be seen by inspecting the lower figures of Pl. VI. At present it is

by no means clear to me that the changes of form are coincident with change of horizon only, or that the differences which separate *Al. Lorieri* from *Al. cochleata* or *Al. trifida* are really of biological import. Piette seems to have more faith in the existence of these differences, and it is quite possible that the superior condition of the French fossils has justified the separation. In addition to any references which may be given the following general references should be noted :

1829 and 1835. ROSTELLARIA TRIFIDA, *Bean*, MS. Phillips G. Y., p. 109, pl. v fig. 14.

Compare also

1836. FUSUS CURVICAUDA, *Roem.* Ool. Geb., p. 140, pl. xi, fig. 6.
1837. CHENOPUS PHILIPPI, *Dunker and Koch.* Beitr., p. 34, pl. ii, fig. 13.
1844. ROSTELLARIA BICARINATA, *Münst.* Goldfuss, Pet., iii, p. 15, pl. 170, 1.
1867. ALARIA COCHLEATA, *Quenstedt.* Piette, Cont. de la Pal. Franç., p. 110, pl. xxii, figs. 1—6.

The *trifida*-group stands out tolerably distinct from all the others. In this country its earliest representative, *Al. Lorieri*, var. *gracilis*, appeared in the *Murchisonæ*-zone of the Cotteswolds. No traces of it are known to me in the Yorkshire Dogger, nor yet in the Lower Division of the Inferior Oolite in Dorsetshire.

53. ALARIA LORIERI, *D'Orbigny*, 1850. Plate VI, figs. 6 *a*, 6 *b*, 6 *c*, 6 *d*; 6 *a'*, 6' *b*; 6'' *a*.

1850. PTEROCERA LORIERI, *D'Orbigny.* Prod., i, p. 270.
1867. ALARIA — — Piette, Cont. de la Pal. Franç., p. 32; see plates ii, iii, iv, and vi.

Compare also

1842. ROSTELLARIA TRIFIDA, *Phillips.* Deslongchamps, Mém. Soc. Linn. Norm., vol. vii, p. 171, pl. ix, ? figs. 27, 28.
1869. CHENOPUS PHILIPPI, *Dunker and Koch.* Brauns, Mittlere Jura, p. 170.
1873. ALARIA LORIERI, *D'Orbigny.* Tawney, Dundry Gasteropoda, p. 13.

Bibliography, &c.—Deslongchamps, who applied the name "*trifida*" to all forms of the group from the Lias to the Kimeridge Clay, traced the species back as far as the Upper Lias of Fontaine-Etoupe-Four. But I cannot find in Piette's work any allusion to the *hamicaudes* having been represented in the Lias.

The following is D'Orbigny's description of "*Pterocera*" *Lorieri*. "A small species near to *Pterocera* (*Chenopus*) *Philippi*, but much more elongate and slender; whorls strongly carinated, finely striated spirally." He does not mention any localities in Normandy but refers to the Department of the Sarthe. Piette

describes three varieties of *Al. Lorieri.* His third variety, which occurs in the "Oolithe ferrugineuse" of Bayeux (*op. cit.*, pl. ii, figs. 12—14, and pl. iii, figs. 11, 12), might be expected to have most resemblance to our Dorsetshire specimens. There are differences in the Dorset-beds but they do not correspond in all cases to the differences indicated by Piette. Viewed broadly we may say that the *trifida*-group is represented in the Inferior Oolite by a series of fossils which in France are recognised for the most part as *Al. Lorieri*, and in Germany as *Al.* (*Chenopus*) *Philippi.* Each of these has its own set of synonyms, and some English palæontologists would designate the whole as *Alaria trifida.*

Without doubt the Burton-Bradstock fossils must be regarded as representing the *Al. Lorieri* of common repute, though possibly not exactly the *Al. Lorieri* of D'Orbigny. Three varieties are shown in the accompanying plate, and these I proceed to describe.

Var. A. (Figs. 6 *a*, 6 *b*, 6 *c*.)

Description :

Length	20 mm.
Width of last whorl to height of shell . .	45 : 100
Spiral angle	35°

Shell fusiform, sub-turrited. Whorls nine; apex moderately blunt; apical whorls tumid without keel or ornament; the five succeeding whorls of the spire are strongly carinate; the carina is median, and in well-preserved specimens is seen to be characterised by a furrow. (This is one of the distinctive features of *Al. Lorieri* according to Piette). There are no longitudinal ornaments, but the spiral lines are regular and conspicuous, being most numerous on the posterior area of each whorl; in the anterior area is a sulcus immediately above the suture, and in the middle of this sulcus is a fine thread-like line, most obvious on the last three whorls; a rim is exposed at the base of the lower whorls, and the suture rather gapes in consequence. The body-whorl is strongly bicarinate, the posterior keel, representing the median carina of the spire-whorls, being the most salient. It gives rise to the posterior digitation (fig. 6 *b*) which rapidly attenuates in describing a curve, whose centre is a point some little way beyond the apex of the shell. The wing is slightly palmate, the intercarinal space being slightly excavated and spirally striated. The anterior digitation, although arising from the least salient keel, becomes wide and bayonet-shaped for a short distance, and after developing a broad, tongue-like process, curves slightly upwards to its blunt termination (fig. 6 *a*).

The aperture is trapezoidal, the outer lip considerably produced, and each of the wing-digitations deeply channelled; the canal is broad and comparatively short, since it curves sharply in a direction opposite to that of the anterior digitation, and to this circumstance much of the grotesque appearance of the shell (in common with other members of the *trifida*-group) is due. This also terminates in a slight expansion.

Var. B. (Figs 6′ *a*, 6′ *b*.)

Description:

Length	19—27 mm.
Spiral angle	28°

This form differs from the one last described in the comparative narrowness of the spiral angle and in the height of the whorls of the spire in proportion to their width. The slight differences of ornamentation are perhaps the result of accident. We may compare these forms in some respects to *Al. gracilis*, Lycett.

Var. C. (Fig. 6″ *a*.)

Description:

Spiral angle about	40°

This specimen, which is deeply embedded in matrix, may be somewhat deceiving in appearance. It is shorter and more widely angled than the majority of specimens, and would do very well to represent the "*Chenopus*" *Philippi* of Dunker and Koch.

Relations and Distribution.—The *Parkinsoni*-zone of the neighbourhood of Burton Bradstock has yielded nearly all our specimens of *Al. Lorieri*. There is a specimen in the Bristol Museum (fig. 6 *d*), apparently a fragment of a large specimen of this species. Elsewhere it is very rare, small, and in poor preservation. Under such conditions *Al. Lorieri* or some member of the *trifida*-group may occasionally be recognised in the Upper Division of the Inferior Oolite in the Cotteswolds. Some specimens of the *trifida*-group occurring in the Lincolnshire Limestone may possibly belong here likewise, though not the forms from Great Ponton (see Pl. VII, figs 1 *a*, 1 *b*, and 2).

54. Alaria Lorieri, D'Orb., var. *gracilis*, Lycett, 1853. Plate VI, fig. 5.

1853. Rostellaria gracilis, *Lycett*. Proc. Cotteswold Nat. Field Club, vol. i, p. 80.

Description.—" Spire lengthened, smooth. Whorls six, lengthened, angulated, the angle being in the middle of the whorl, forming an acute and crenulated carina; body-whorl smooth, with two carinæ and large digital processes; caudal extremity slender and lengthened. The slender form, crenulated carina, and smooth surface distinguish it from *R. trifida.*"—Lycett.

The figured specimen, which is believed to be Lycett's type, presents no crenulations other than the result of usage, and this is also the cause of the smoothness, the spiral lines having been rubbed down almost to obliteration. The appearance of smoothness in fossils obtained from oolitic freestones is in most cases merely due to rolling. The " caudal extremity " is not particularly lengthened, and there are indications in the specimen of the commencement of the hamicaudal curve. The mean spiral angle is about 28°.

Relations and Distribution.—This variety is more slender than the majority of the specimens referred to *Al. Lorieri* from the *Parkinsoni*-zone of Burton Bradstock. It may, in fact, represent the typical *Al. Lorieri* of D'Orbigny.

There is a particular interest attaching to the figured specimen, viz. that it is the earliest recorded example of the *trifida*-group in this country. It was obtained from the Freestones below the Oolite-Marl near Leckhampton, which are well within the *Murchisonæ*-zone. Such fossils must be extremely rare, since no species of the *trifida*-group is quoted from any horizon of the Inferior Oolite in Witchell's ' Geology of Stroud.' Since the few species of *Alariæ* hitherto discovered in the British Lias appear to belong to the Monodactyl section, this is the earliest Didactyl *Alaria* known in this country.

55. Alaria pontonis, sp. nov. Plate VII, figs. 1 *a*, 1 *b*, and var. *spinifera*, Plate VII, fig. 2.

Description :

Length	22 mm.
Width of body-whorl to height of shell . .	50 : 100
Spiral angle	42°

Shell fusiform, scarcely turrited, spire convex. Whorls about nine (only seven observed), tumid; the two sub-apical whorls have longitudinal costæ (rarely to be seen for lack of preservation); the two succeeding whorls are either smooth or marked with very fine spirals. Up to this point the increase of the shell is very slow. About the seventh whorl a change takes place, the shell begins to develop more rapidly, a sort of keel is formed somewhat above the middle of the whorl, which is spirally striated throughout; in the penultimate the keel is more pronounced; above the keel the spiral lines are fine and close, below the keel are three primary spirals with very fine intermediate lines. The body-whorl is ventricose, and bicarinate, the upper carina being the most prominent; the spiral ornamentation is continued throughout, and into the base of the shell; there are three principal spiral lines between the digitations. The wing rather broad and didactyl, each carina giving rise to a digitation; the posterior is somewhat the narrower, and sweeps upwards in a curve whose centre is situated near the apex of the shell. The anterior digitation has a tolerably sharp downward curve; it is short, thick, terminating in a sort of blunt point.

The aperture is trapezoidal, the outer lip projecting, the wing digitations being slightly channelled. The canal-sheath is thick and short, with a sharp upward curve.

The variety *Spinifera* differs from the shells previously described thus:—no longitudinal costæ have been detected on the sub-apical whorls (but this may arise from the accidents of preservation); the general outline is less smooth, whereby the anterior whorls are rendered somewhat more angular; the anterior digitation is directed more outwards, and with less of an anterior curve. But the chief difference lies in the tendency to develop spines; the upper carina of the body-whorl carries one or two spines, which are differently placed in different individuals, sometimes a quarter of a turn, sometimes half a turn, above the base of the posterior digitation. In some specimens there seems to have been some on the penultimate.

Strictly speaking, this form, which is the commoner of the two, should be regarded as more typical than the smooth specimens.

Relations and Distribution.—Always bearing in mind that this species is a member of the *trifida*-group, it may be separated from *Al. Lorieri* by the non-carinate character of the earlier portions of the spire, by the very different shape of the anterior digitation, by the proportional shortness of the highly curved "tail," and by the more pupoid aspect of the whole shell, besides minor points of ornamentation. The var. *Spinifera* still further differs in the development of spines.

It has much closer affinities with *Alaria pupœformis*, D'Archiac, a fossil of the Great Oolite of the East of France. Piette (*op. cit.*, p. 85, Pl. 13, figs. 1—8)

PLATE I.

(All figures natural size, unless otherwise stated.)

FIGS.

1 *a*, 1 *b*. *Purpurina elaborata*, Morris & Lycett. *Sowerbyi*-bed, Bradford Abbas. My collection. (Page 85.)

1 *c*, 1 *d*. The same. Another specimen. Same horizon and locality. Buckman collection. 1 *e*, same specimen, part enlarged.

1 *f*. The same. Another specimen. Lincolnshire Limestone, Weldon. My collection. Enlarged.

1 *g*. The same. Another specimen. Dogger, Blue Wyke. Leckenby collection.

2. *Purpurina*, species or variety. *Sowerbyi*-bed, Bradford Abbas. Buckman collection. (Page 91.)

3 *a*, 3 *b*. *P. cancellata*, sp. nov. Stoford? My collection. (Page 87.)

4 *a*, 4 *b*. *Purpurina*, species or variety. (? Oolite-Marl.) Nailsworth. Jermyn Street Museum. (Page 87.)

5 *a*, 5 *b*. *P. bellona*, D'Orb. Var. with fine ribs. *Parkinsoni*-zone, Grove. My collection. (Page 89.)

5 *c*, 5 *d*. The same. Var. with coarse ribs. *Parkinsoni*-zone. Vitney Cross. My collection.

5 *e*, 5 *f*. The same. Another specimen. Same horizon, locality, and collection. 5 *g*, same specimen, apical view.

6 *a*, 6 *b*. *P. curta*, sp. nov. *Humphriesianus*-zone, Milborne Wick. My collection. (Page 90.)

7 *a*, 7 *b*. *P. bellona*, var. *pagoda*. *Parkinsoni*-zone, Burton Bradstock. 7 *c*, apical view. (Page 89.)

8 *a*, 8 *b*, 9 *a*, 9 *b*. *Purpurina;* doubtful forms, related to *P. pagoda*. (Page 89.)

10 *a*, 10 *b*. *P. parcicosta*, sp. nov. ? *Sowerbyi*-bed, Bradford Abbas. My collection. (Page 90.)

11 *a*, 11 *b*. *P. aspera*, sp. nov. *Sowerbyi*-bed, Bradford Abbas. Buckman collection. (Page 91.)

11 *c*, 11 *d*. The same. Another specimen. Same horizon and locality. My collection.

11 *e*. Large specimen of *P. aspera*, probably from same place. Jermyn Street Museum.

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PLATE II.

FIGS.

1 *a*, 1 *b*. *Purpurina calcar*, sp. nov. *Sowerbyi*-bed, Bradford Abbas. My collection. (Page 91.)

2 *a*, 2 *b*. *P. inflata*, Tawney. *Parkinsoni*-zone. Burton Bradstock. My collection. 1 *c*, apical view. (Page 92.)

2 *d*, 2 *e*. The same. Another specimen. Inferior Oolite, Dorsetshire. My collection.

2 *f*. The same. Another specimen. I. O., Rodboro' Hill. Jermyn Street Museum.

3 *a*, 3 *b*. *P. rotunda*, sp. nov. *Sowerbyi*-bed, Bradford Abbas. Buckman collection. 3 *c*, apical view. (Page 93.)

3 *d*. The same. Another specimen. I. O., Dorsetshire. Jermyn Street Museum.

4 *a*, 4 *b*. *P. tabulata*, sp. nov. *Sowerbyi*-bed, Bradford Abbas. My collection. 4 *c*, apical view. (Page 94.)

4 *d*, 4 *e*. Var. of *P. tabulata*. *Sowerbyi*-bed, Bradford Abbas. My collection.

5 *a*, 5 *b*. *P.* (*Eucycloidea*) *bianor*, D'Orbigny. *Parkinsoni*-zone, Burton Bradstock. My collection. × 1½. 5 *c*, apical view × 3. (Page 95.)

5 *d*, 5 *e*. The same. Another specimen. × 1½.

5 *f*, 5 *g*. The same. Small specimen. × 2. 5 *h*, aperture × 4.

6 *a*, 6 *b*. *P.* (*Eucycloidea*) "*fusiforme*." Inf. Ool. "Yeovil." Woodwardian Museum × 1½. (Page 96.)

7 *a*, 7 *b*. *P.* (*Eucycloidea*) *carino-crenata*, Lycett. Inferior Oolite. Jermyn Street Museum. × 1½. (Page 97.)

8 *a*, 8 *b*. *Brachytrema Wrightii*, Cotteau, var. *despecta*. *Parkinsoni*-zone, Vitney Cross. My collection. × 4. 8 *c*, basal view. (Page 99.)

9 *a*, 9 *b*. *B. sub-varicosum*, sp. nov. Lincolnshire Limestone, Great Ponton. British Museum. × 4. (Page 98.)

10 *a* 10 *b*. *? Alaria varicifera*, sp. nov. Lincolnshire Limestone. × 4. See also Pl. VII, figs. 8 *a*, &c.

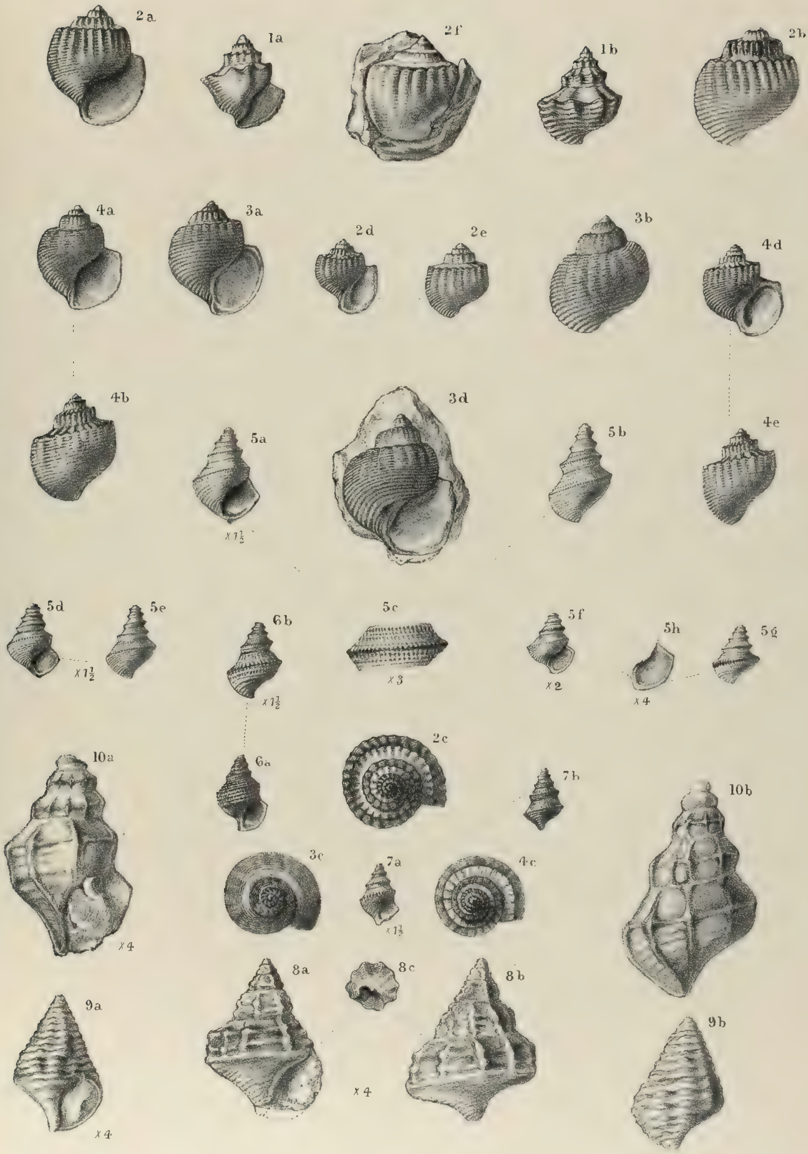

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PLATE III.

FIGS.

1 *a*. *Malaptera Bentleyi*, Morris & Lycett. Collyweston Slate. Jermyn Street Museum. (Page 101.)

1 *b*. The same. Another specimen. Impression in gutta percha. My collection.

1 *c*. The same. Another specimen. Impression in gutta percha. My collection.

2. *M. Bentleyi*, var. *neglecta*. Impression in gutta percha. Collyweston Slate. My collection. (Page 102.)

3 *a*. *Spinigera trinitatis*, Tawney. *Sowerbyi*-bed, Bradford Abbas. My collection. 3 *b*, part of spire × 3. (Page 103.)

3 *c*, 3 *d*, 3 *e*. The same. Another specimen. Buckman collection.

4 *a*, 4 *b*. *S. longispina*, Deslongchamps. *Humphriesianus*-zone (*? Sauzei*-bed), Sherborne. Buckman collection. Two specimens. (Page 104.)

4 *c*. The same. Another specimen. *Humphriesianus*-zone, Milborne Wick. My collection.

5 *a*. *S. recurva*, sp. nov. *Parkinsoni*-zone, Burton Bradstock Cliff. My collection. (Page 105.)

5 *b*. The same. Another specimen. *Parkinsoni*-zone, Vitney Cross. My collection. × $1\frac{1}{2}$.

5 *c*, 5 *d*. The same. Another specimen. *Parkinsoni*-zone, Upper Loders. 5 *e*, spire × 3.

5 *f*. The same. Another specimen. "Blackrock, Bridport." Jermyn Street Museum. × $1\frac{1}{2}$. 5 *g*, whorl × 2. 5 *h*, apical portion of spire × 4.

6 *a*. *S. didactyla*, sp. nov. *Sowerbyi*-bed, Bradford Abbas. My collection. (Page 106.)

6 *b*. The same. Another specimen. Buckman collection.

6 *c*. The same. Another specimen. Buckman collection.

6 *d*. Variety of *S. didactyla*. ? Bradford Abbas. Jermyn Street Museum. 6 *e*, *f*, *g*, the same, under three different aspects × $1\frac{1}{2}$.

7. *S. crassa*, sp. nov. *Sauzei*-bed, Oborne. My collection. (Page 107.)

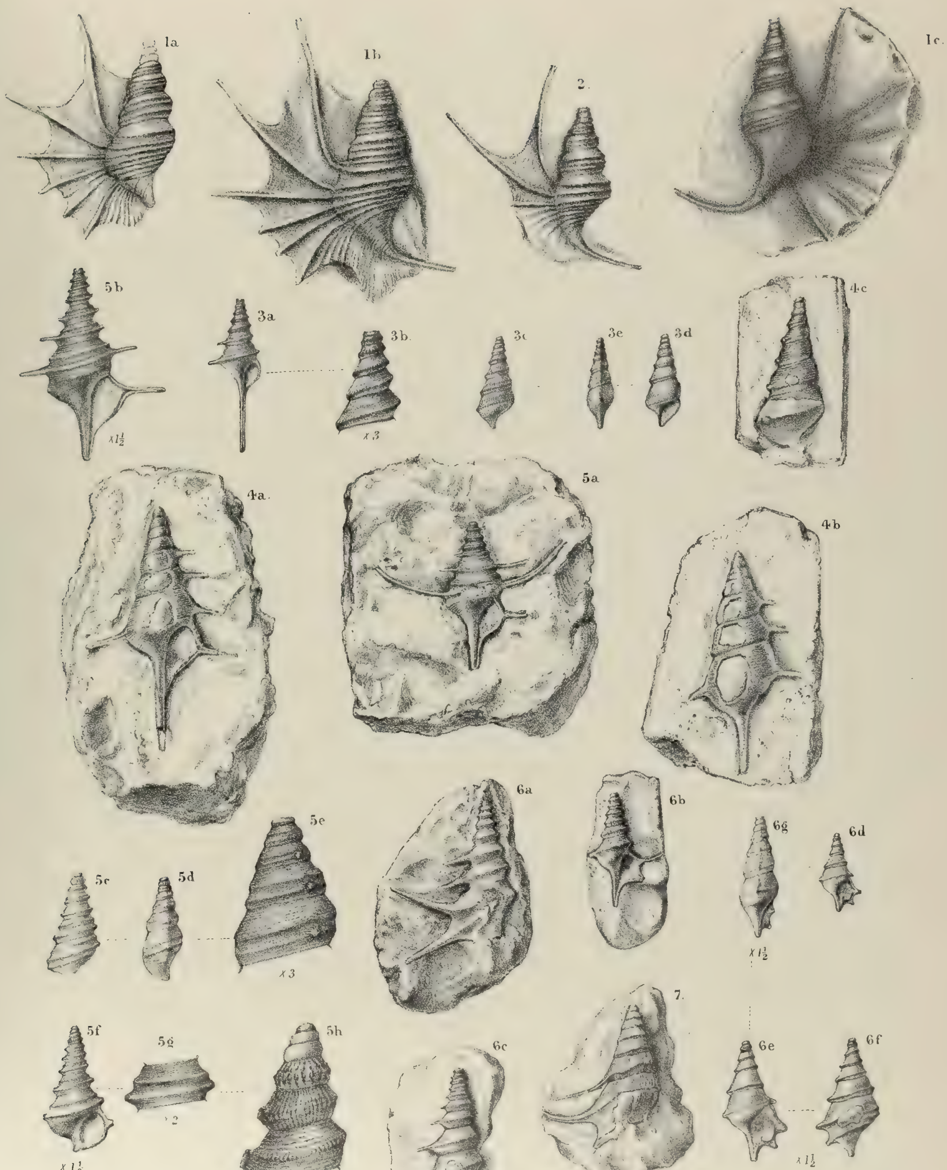

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PLATE IV.

FIGS.

1. *Alaria arenosa,* Hudleston. Dogger Sands. Leckenby collection. (Page 110.)
2. *Al. angusta,* sp. nov. Inferior Oolite. Bristol Museum. (Page 111.)
3. *Al.* "*crassicostata.*" Dogger, Blue Wyke. My collection. (Page 111.)
4. *Al.* "*Hortonensis.*" *Parkinsoni*-zone, Horton Hill. My collection. (Page 112.)

5 *a, b.* *Al.* "*spinulosa.*" Two specimens. Dogger, Blue Wyke. (Page 113.)

6 *a, b, c, d.* *Al. hamus,* Deslongchamps. Four specimens. *Parkinsoni*-zone, Burton Bradstock. My collection. (Page 113.) See also Pl. VII, fig. 9.

7 *a.* Dwarfed var. of *Al. hamus.* *Parkinsoni*-zone, Notgrove. 7 *b,* another specimen. *Parkinsoni*-zone, Horton Hill. My collection. (Page 115.)

7 *c.* Another variety, "*tricincta.*" Gryphite-grit near Stroud. Witchell collection. (Page 115.)

8 *a.* *Al. hamus,* var. *Phillipsii,* D'Orb. Scarborough Limestone, Cloughton Wyke. My collection. 8 *b,* specimen from the Dogger. 8 *c,* from Millepore Rock or Scarborough Limestone. Both Leckenby collection. (Page 116.)

9. *Al. hamus,* var. *nodosa.* Inferior Oolite, Stoford. Buckman collection. (Page 117.)
10. *Al. pinguis,* sp. nov. Inferior Oolite, Dorset. My collection. (Page 117.) See also Pl. VII, fig. 11.
11. Immature form of *Alaria ? Phillipsii.* Gryphite-grit, near Stroud. Witchell collection. (Page 115.)
12. *Al.* cf. *rarispina,* Schlumberger. *? Sowerbyi*-bed, Dorset. Whidborne collection. (Page 118.)

13 *a, b, c.* *A. unicarinata,* Hudleston. Three specimens. Dogger, Blue Wyke. My collection. (Page 118.)

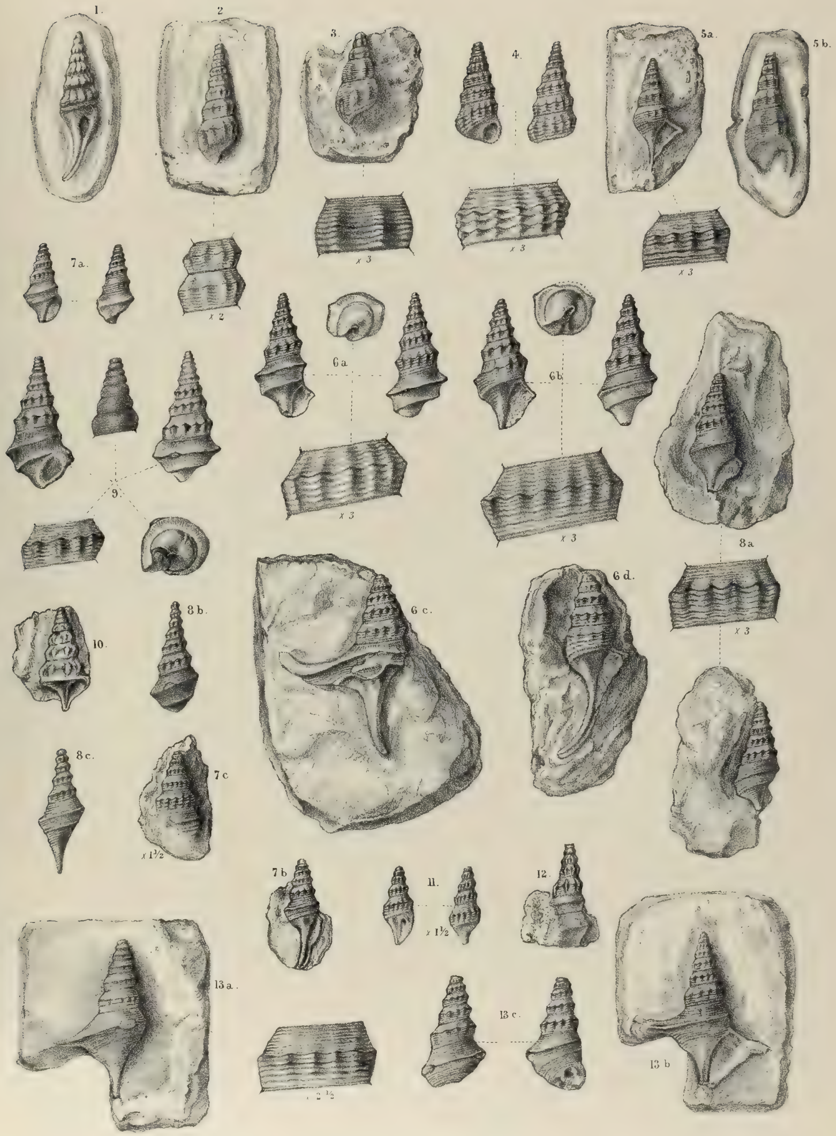

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PLATE V.

FIGS.

1. *Alaria unicornis*, Lycett. I. O., Nailsworth. Jermyn Street Museum. (Page 119.)
2. *Al. Dundryensis*, Tawney. Type RE-FIGURED. I. O., Dundry. Bristol Museum. (Page 122.)
3. *Al. fusca*, sp. nov. *Cadomensis*-bed. Oborne. My collection. (Page 121.)
4. *Al.* "*alienigena*." I. O., Dorsetshire. My collection. (Page 121.)

5 *a*. *Al. Roubaleti*, Schlumberger, var. *Dorsetensis*. *Sowerbyi*-bed, Bradford Abbas. My collection. Showing front and base.[1] (Page 123.)

5 *b*. The same. Wide-angled variety. I. O., Dorsetshire. My collection.

5 *c*. The same. Another specimen. I. O., Dorsetshire. My collection.

5 *d*. The same. Another specimen. *Sowerbyi*-bed, Bradford Abbas. Buckman collection. See also Pl. VII, fig. 10.

5 *e*. The same. Immature form. *Sowerbyi*-bed, Bradford Abbas. My collection.

5 *f*. The same. Small variety. Scarborough Limestone, Pickering Cliff. My collection.

6. *Al. Roubaleti*, Schlumb., var. "*dimidiata*." *? concavus*-bed, Halfway House. Whidborne collection. (Page 124.)

7 *a*. *Al.* (compare) *unicornis*, Lycett, var. *Bradfordiensis*. *Sowerbyi*-bed, Bradford Abbas. Buckman collection. (Page 120.)

7 *b*. The same. *Murchisonæ*-zone, Bradford Abbas. My collection.

8. *Al. pseudo-armata*, Hudleston. Dogger, Blue Wyke. Leckenby collection. (Page 125.)
9. *Al. Lotharingica*, Schlumberger. I. O., Dundry. Bristol Museum. (Page 125.)
10. *Al. prælonga*, sp. nov. *Murchisonæ*-zone, Halfway House. Buckman collection. (Page 126.)
11. *Al. Doublieri*, D'Orb. var. B. *Cadomensis*-bed, Oborne. My collection. (Page 128.)

[1] Explanation of letters—*a*, anterior spine; *p*, posterior spine; *c*, canal sheath (tail); *w*, wing.

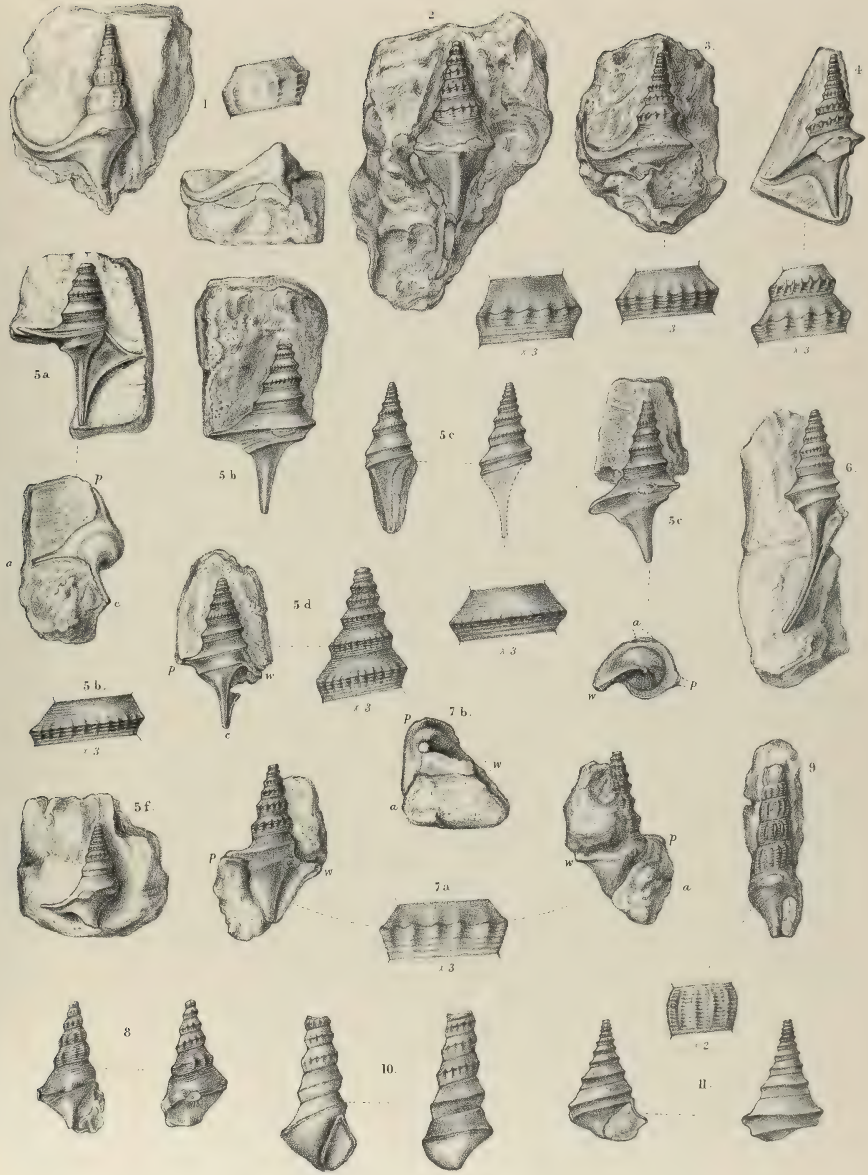

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PLATE VI.

FIGS.

1 *a*. *Alaria Doublieri*, D'Orbigny, var. A. I. O., Dorset. My collection, quarter-view (midway between back and front), and base. (Page 127.)

1 *b*. The same. Another specimen. I. O., Halfway House. Whidborne collection.

1 *c*. The same. Another specimen. I. O., Dorset. My collection.

2. *Al.* "*dubia*." I. O., Dorset. My collection. (Page 129.)

3 *a*. *Al. sublævigata*, sp. nov. *Sowerbyi*-bed, Bradford Abbas. My collection. (Page 129.)

3 *b*. The same. Another specimen. Dogger, Blue Wyke. Leckenby collection.

3′ *a*. *Al. sublævigata* var. *Sowerbyi*-bed, Dorset. Buckman collection. (Page 130.)

3′ *b*. The same. Another specimen. *Sowerbyi*-bed, Bradford Abbas. Buckman collection.

4 *a*. *Al. myurus*, Deslongchamps. I. O., Dundry. Woodwardian Museum. (Page 130.)

4 *b*. The same. *Clypeus*-grit variety, Rodboro' Common. Witchell collection. 4 *c*, the same. Same locality and collection.

5. *Al. Lorieri*, D'Orb., var. *gracilis*, Lycett. Freestones below Oolite Marl, Leckhampton. Brodie collection. (Page. 135)

6 *a*. *Al. Lorieri*, D'Orb., var. A. P_1, Burton Bradstock Cliff. My collection. (Page 133.)

6 *b*. The same. Another specimen. P_1, Loders. My collection.

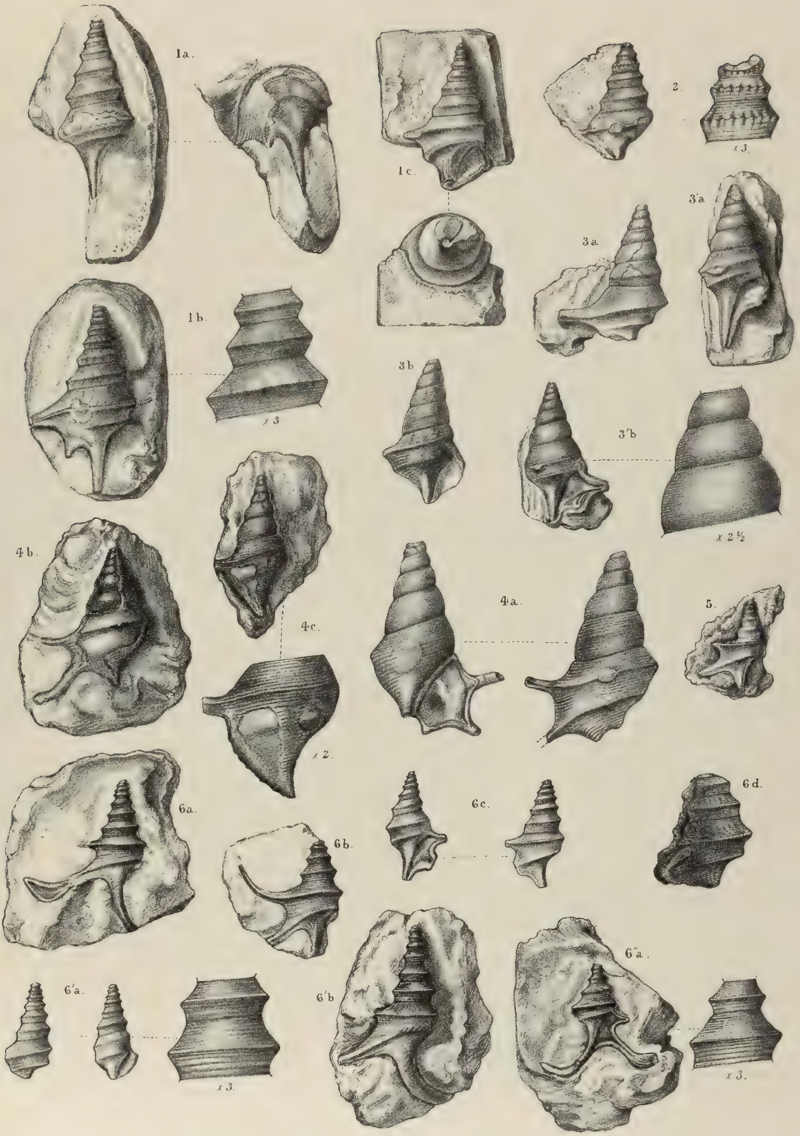
6 *c*. The same. Another specimen. P_1, Burton Bradstock Cliff. My collection.

6 *d*. The same. Another specimen. ? I. O., Dundry. Bristol Museum.

6′ *a*. *Al. Lorieri*, D'Orb., var. B. P_1, Burton Bradstock Cliff. My collection. (Page 134.)

6′ *b*. The same. Another specimen. P_1, Vitney Cross. My collection.

6″ *a*. *Al. Lorieri*, D'Orb., var. C. P_1, Burton Bradstock Cliff. My collection. (Page 134.)



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THE

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LONDON:

MDCCCLXXXVIII.

A MONOGRAPH

ON THE

INFERIOR OOLITE AMMONITES

OF

THE BRITISH ISLANDS.

BY

S. S. BUCKMAN, F.G.S.

PART II.

PAGES 25—56. PLATES VII—XIV.

LONDON:

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Lioceras bradfordense, *var.* giganteum, *S. Buckman.* Plate XI, fig 1; Plate XII, figs. 4—7.

Adult.—Discoid, subcarinate, whorls somewhat compressed, slightly subconvex, ornamented with mere lines of growth; ventral area sloping towards a small, hardly distinct carina. Inner margin regularly concave and sloping. Inclusion considerable, normally nearly three-fourths of the preceding whorl. Umbilicus rather deep on account of the absence of any depression on the inner area, and regularly showing portions of the inner whorls.

Immature.—At a diameter of about two inches (Plate XII, figs. 5, 6, 7):—whorls slightly subconvex, ornamented with not very prominent, simple, sigmoidal ribs, which are obscure on the inner area. Ventral area smooth and flat, with a small, barely distinct carina. Inclusion two-thirds. Umbilicus small and deep, showing portions of the inner area of each whorl down to the centre.

At a diameter of about six inches:—ribs single, commencing to become obscure, especially on the inner area. Ventral area smooth, with the carina somewhat more prominent at this age than any other. Inclusion three-fourths of preceding whorl. Umbilicus showing a portion of the inner area of each whorl, which portions exhibit at first some small ribs but are now becoming smooth.

The thickness of this variety and its small, deep umbilicus, mark it off as a form which must necessarily attract attention, and at first sight cause it to seem very different from either of the other forms of *Lioceras bradfordense.* I say *other* forms because, to be quite correct, I ought to notice that, in reality, with this one there are figured three forms of *Lioc. bradfordense*, showing certain differences from each other. Of the typical variety (at least the one which I had in view when I first mentioned the fossil[1]), an immature specimen is figured, Plate IV, figs. 5, 6; on Plate V a slightly thinner form with wider umbilicus is figured, which, to speak with great precision, is not the more adult form of Plate IV, figs. 5, 6, but of fig. 7; while opposed as it were to this form, but seemingly more distinct from the typical form, is the one we are now treating of, much thicker and with a small, deep umbilicus. The thick and the thin forms seem to be more peculiar to the Beaminster district, while my specimens of the intermediate or typical forms come from Bradford Abbas. Between this form and *Ludwigia Murchisonæ* there can hardly be any chance of that confusion which, as I have already shown, may possibly occur between the thin form and that species on account of their remarkable convergence in some respects. A comparison, however, of these forms of *Lioceras bradfordense* with *Ludwigia Murchisonæ* on one side and with *Lioceras concavum*

[1] 'Quart. Journ. Geol. Soc.,' 1881, p. 604.

on the other, might lead a superficial observer, taking no account of ribbing or suture-line, to suppose that the derivation of *Lioceras concavum* from *Ludwigia Murchisonæ* could be demonstrated. We know, however, that the genus *Lioceras* began, at any rate in the Upper Lias, with *Lioceras elegans*, Young (not *Harpoceras elegans*, Sowerby),[1] and *Lioceras elegans* is naturally the most probable progenitor of the other species of this genus.

From *Lioceras concavum* this variety is easily separable by its greater thickness, and its umbilicus showing portions of the inner whorls throughout all stages of growth; from the thicker forms of *Lioceras v-scriptum* the difference in ribbing, sigmoidal instead of V-shaped, always distinguishes it, in addition to the other features, or even when some of the smaller specimens of *Lioceras v-scriptum* have a tendency to depart from the ordinary concave umbilicus (Plate X, fig. 7). The young of this form have a great resemblance to a small variety of *Lioceras concavum*, viz. *Lioc. pingue*, which, however, possesses finer ribs and continues always with a concave umbilicus (Plate XII, fig. 3 and fig. 7, show the difference in this matter). *Lioc. pingue* also never attains a much larger size than the specimen figured. *Lioceras giganteum* occurs in the *Murchisonæ*-zone at Beaminster with specimens of *Lioceras bradfordense*. I do not know of its occurrence in the Bradford Abbas district.

Plate XI, fig. 1, shows the side view of a very large adult specimen with the greater portion of the test in a fair state of preservation. A large part of the specimen has not been placed upon the plate, as it shows no different character. The last suture is situated at the ×. This specimen is from Beaminster and is in my collection. Plate XII, fig. 4, gives the front view of this specimen. The test is present on the ventral area, and is seen on the top of the figure. Plate XII, fig. 5, shows a young specimen from Stoke Knap, near Broad Windsor, Dorset, in my collection; fig. 6 displays the front view; and fig. 7 a sectional view of the umbilicus to compare with fig. 3.

LIOCERAS AMBIGUUM, *S. Buckman*. Plate VII, figs. 1—6.

The Type.—Discoidal, much compressed, subcarinate, whorls merely ornamented with very fine sigmoidal lines of growth, which at an earlier stage of the shell have exhibited a slight tendency to form very fine ribs. Whorls distinctly convex, forming a slight ridge; this is situated nearly in the middle, and gives to the inner portion with the umbilicus, a regularly depressed, plate-like appearance, only relieved by another slight ridge on the edge of the inner margin. The ventral area is narrow, and slopes towards a small, scarcely distinct carina; but on the body-

[1] See "Jurassic Ammonites," S. Buckman, 'Geol. Mag.,' 1887, dec. ii, vol. iv, No. ix, pp. 398—400.

chamber the ventral area is convex, scarcely defined, and has an indistinct keel. This keel is at first formed by the junction of the two convex portions of the ventral area, continuing to meet at a gradually less and less angle, until towards the end of the body-chamber the ventral area is very nearly rounded. Inner margin very shallow, much sloped on the body-chamber and concave, sometimes slightly crenulated by the ends of the small radii in the interior. The amount of inclusion exhibited at the mouth in the type is a trifle less than half a whorl. (In the figure a little too much inclusion is shown here.) At a whorl farther back, we find that nearly the whole of the preceding whorl is occluded. (A trifle too much of this whorl is shown in the figure.) Previous to this we find that the amount of inner whorls exposed is proportionately more, and they show us that in youth the specimen was possessed of ribs. The mouth-border is seen in fig. 3, taken from a slightly larger specimen, which exhibits its sigmoidal shape very well. Fig. 4 gives a view from above showing the rounded end of the ventral lappet, but this figure omits to give a very slight keel, which is just perceptible along the middle of the ventral area.

A larger specimen, probably adult, measuring $6\frac{1}{2}$ inches in diameter, shows the same characters, but the coiling of the umbilicus is more regular, so that the amount of the inner whorls exposed is rather greater, and the appearance flatter, and the recession of the whorl at the body-chamber is not so abrupt.

Young Shell (figs. 5, 6).—Compressed, subcarinate, whorls nearly parallel, slightly concave along the inner area. Up to the diameter of about 10 lines the whorls are evidently ornamented with ribs, probably V-shaped, and sometimes uniting close to the inner margin; beyond that size the ribs gradually give place to similar lines of growth, with occasional undulations in the shell. The ventral area is broad compared with the other parts of the aperture, and flattened, with a small, just distinct carina. The inner margin is not defined until the ribs disappear, then it becomes concave. The umbilicus is wide and open on account of the presence of the whole of the body-chamber with its receding inner margin. (The actual mouth-border has been slightly broken.) The inclusion is about half a whorl, but evidently, to conform to the dimensions of the umbilicus of the type, the inner margin must for a whorl back advance towards the centre (supposing the shell to continue its growth), and envelop nearly the whole whorl as the additional air-chambers are formed.[1]

This is a species which, when well preserved, may readily be separated from the others, but a comparison of poorly-preserved specimens makes the task very difficult. Fortunately most of the specimens of this and the other species are in good preservation, but especially the specimens figured on Plate VII, figs. 1, 2, 5, 6.

[1] This shows that alterations took place in the air-chambers and in the position of the inner margin, and that when the air-chambers had been partitioned off they were not unalterably fixed, but still had to undergo certain developments and modifications. The whole genus *Lioceras* gives us examples of this, but perhaps this species more than any other.

The peculiarities of this species are an inflation and gibbosity of the outer portion and ventral area of the whorl immediately preceding, and up to, the mouth-border; the very early age at which it becomes quite smooth, merely exhibiting very fine lines of growth (the small ribs shown on fig. 1 are rather too distinct, and are not exhibited by other specimens); and the depressed inner portion of the shell extending from the middle of the whorl to the same part of the same whorl opposite. The species from which it is most difficult to separate this are *Lioceras opalinum* (the open form, Plate XIII, fig. 7), *Lioc. decipiens*, and *Lioc. bradfordense*. The fine striæ on the type-specimen are produced on the lateral area much more than on the ventral, over which they pass almost at right angles to the keel, and this is especially noticeable on the body-chamber. In fig. 4 the striæ are rather more produced on the ventral area, as is shown by the drawing of the mouth-border, but they are quite as much produced on the lateral area. This flexure of the striæ enables us to separate the species from *Lioc. opalinum*, in which the forward sweep of the striæ on the ventral area is rather peculiar. Besides this, the greater thickness, the depressed inner portion I have mentioned, the possession of ribs in youth, and the expansion in the umbilicus when the body-chamber is present, separate this species from *Lioc. opalinum*. From *Lioc. bradfordense* the separation is not so obvious. The more discoidal form, caused by its being thinner and also by the depressed inner portion; the fact of its being smooth at a very early age; the more rounded ventral area of the body-chamber; the small but suddenly expanding umbilicus (not regular as in *Lioc. bradfordense*); but more especially the very different front view; these are the chief points of difference. This front view as well as the thinner, less conspicuous carina, the more sloping ventral area, and the larger umbilicus, distinguish it from *Lioc. decipiens*.

Lioc. ambiguum occurs in the Paving-bed (*Murchisonæ*-zone) of Bradford Abbas, and also in a quarry near Sherborne, Dorset; but is certainly a scarce form.[1] This species has been quoted from Bradford Abbas under the name *Am. aalensis*, Zieten (*Am. candidus*, d'Orb), a species which has different sutures, different ribs, different umbilicus, ventral area, and sectional view.

Plate VII, fig. 1, exhibits a very finely-preserved specimen collected by my father many years ago. Fig. 2 gives the front view, a most characteristic feature in this species. Figs. 3, 4 are the termination of another specimen. Figs. 5, 6, represent a young specimen of this species, fig. 5 marking the open umbilicus caused by the presence of the body-chamber. All the specimens are from Bradford Abbas.

[1] A poorly preserved specimen, doubtfully referred to this species, I obtained from Haresfield Hill, Bed 10, Section V (p. 43).

LIOCERAS AMBIGUUM, *var.* COSTATUM, *S. Buckman.* Plate VII, fig. 7.

Discoidal, compressed, sub-carinate, whorls almost flat, ornamented with sigmoidal ribs, which are not much bent on the lateral area, and are rather irregular in size, especially on the body-chamber, where they really become undulations. Ventral area narrow and sloping, with a small, barely distinct carina. On the body-chamber the ventral area becomes broader and flatter; and, the carina almost disappearing, the ventral area on the end of the body-chamber appears nearly rounded, while the lines of growth, which were formerly curved forwards on it, now pass over it nearly at right angles. Inner margin sloping and concave. Inclusion covers nearly the whole whorl except where the body-chamber is present, when it suddenly decreases to half the whorl, as is shown in the specimen figured. The mouth-border, of which a portion is shown on the figured specimen, is probably like that in *Lioceras ambiguum.*

This form differs from the true *Lioceras ambiguum* in having a smaller, deeper umbilicus, a less compressed inner area, and well-marked ribs, which last are most conspicuous on the middle of the lateral area, and on the body-chamber gradually become more like waves. (The irregularity of the ribs, depressions, and fine sigmoidal lines of growth are hardly sufficiently brought out in the figure.) Like *Lioc. ambiguum* it possesses a somewhat inflated, slightly gibbous, outer and ventral area near the end of the body-chamber; but, not having such a marked depression in the inner area, it does not show this character so conspicuously. From *Lioc. bradfordense* this form is best separated by its irregular ribs. They do not actually bifurcate, but between them intermediate ribs occur on the outer portion of the whorl. The ribs, too, are more conspicuous on the middle of the lateral area, whilst those of *Lioc. bradfordense* are stronger on the outer area. The shape of the umbilicus also differs, being more occluded, especially in the inner whorls. The whole shell is also thinner than *Lioc. bradfordense;* and in all its proportions except the size of its umbilicus, and in not having quite so much depression, it closely agrees with *Lioc. ambiguum.*

I have every reason to believe that the *Murchisonæ*-zone is the correct horizon in which this variety is found. The figured specimen has not its locality recorded, but I judge it to be from Haselbury in Somerset. From that locality I have some other very closely allied forms, not well preserved, which differ slightly in their ribbing and the coiling of the umbilicus, but not materially in their general appearance.

In all these specimens the suture-line differs slightly from the sutures of *Lioceras* in general in having a deeper superior lateral saddle (a singular fact when we consider that such usually accompanies ribs that are much produced on the lateral

area), a shorter inferior lateral lobe, and a rather greater distance between the sutures.[1] Haselbury is the only locality where I know this form in the South-west, and it is evidently very scarce; but I have obtained, from Birdlip, in Gloucestershire, from a fallen block of Oolite belonging probably to the Sandy Ferruginous beds,[2] a portion of a specimen which has every appearance of being this form.

Plate VII, fig. 7, shows a well-preserved specimen of *Lioceras costatum*, with its test complete and the commencement of the mouth-border. The absence of a piece of test on the other side shows us the sutures.

Lioceras decipiens, *S. Buckman*. Plate XII, figs. 8, 9.

Discoidal, much compressed, carinate, whorls very slightly convex, entirely without any ornamentation except sigmoidal lines of growth. Ventral area very narrow, only slightly sloped, with a carina somewhat distinct except on the body-chamber. Inner margin sloping, concave, and shallow. Inclusion normally about three-fourths of the whorl, slightly less when the body-chamber is present. Umbilicus small, with a constant increase of the amount exposed, and with few turns because the diameter of the shell increases quickly on account of the breadth of the whorls.

It is possible to confound *Lioceras decipiens* with almost any of the other species of this genus; but if the points of divergence be accurately noted and the determination of the other species be correctly made, it will be seen that this one differs in many points, which, though individually small, become collectively important. From any varieties of *Lioceras concavum* with which I am acquainted it is separable by the entire absence of ribs, by its larger umbilicus, which continually exposes a greater amount of the inner whorls, by the flatness, but not actual concavity, of the inner area, and by the more actual separation of the carina from a flatter ventral area. It has a peculiar umbilicus, smaller than that of *Lioc. bradfordense*, and, when the body-chamber is absent, even smaller than that of *Lioc. giganteum*; but when the body-chamber is present the umbilicus expands suddenly to about the same size as the umbilicus of the latter *without* its body-chamber, so that this species can be readily distinguished by its method of coiling. It is also smoother at all ages, much thinner and flatter, with more parallel sides, broader whorls, a narrower and flatter ventral area, and therefore seemingly a more important carina. The last, too, distinguishes it from *Lioc. opalinum*, which has a much sloping ventral area without a distinct carina, and has not such a sudden expansion

[1] My present intention is to figure the suture-lines of the various species together in convenient groups for the sake of comparison, and then to discuss them.

[2] See section of Haresfield Hill (p. 43). The beds described as D′ are probably on the horizon from which this specimen came.

of the umbilicus at the body-chamber. From *Lioc. ambiguum* its front view, more parallel sides, and smaller umbilicus, will distinguish it.[1]

The horizon of this species is very easily determined because in the matrix of the body-chamber of the figured specimen are embedded some examples of *Rhynchonella ringens*. This would prove it to come from the lower part of the *Sowerbyi*-zone (*Concavum*-beds). Judging from the matrix, the species occurs near Sherborne, Dorset; but it is certainly scarce, and I do not know of it in any other part of the district.

Plate XII, fig. 8, represents a good specimen of this species with its test well preserved. The whole of the body-chamber is present and a part of the termination. [The piece of test on the body-chamber has been transferred from the other side of the specimen for the purpose of figuring.]

Lioceras decipiens, *var.* simile, *S. Buckman.* Plate XV, figs. 1, 2.

I have only this one specimen of a very peculiar form, which is so well preserved and has such marked and yet similar characters, that I have thought it well to distinguish it by a varietal name. Mr. Gawan has given a very good figure of it, from which it will be seen that it has a great resemblance to *Lioceras decipiens*; but it differs in possessing very small ribs on the outer area at a later age, in having a much smaller umbilicus with deeper walls, and in being considerably thicker. We perceive what is probably the commencement of the termination, and the × shows the length of the body-chamber. There is a peculiarity in the structure of the carina, which is broadish, rounded, distinct from the ventral area, and yet not prominent, which, together with the smoothness of the test, at once seem to unite this form to *Lioc. decipiens.* If we compare the figure of this form with the large figure of *Lioceras giganteum*, we see much resemblance, and, did we not possess a series of smaller specimens of the latter, we might reasonably consider *Lioc. simile* to be the young of *Lioceras giganteum.* The umbilicus of *Lioc. simile* is fairly well preserved, and allows of examination, but the large specimen of *Lioc. giganteum* does not possess quite all the umbilicus drawn by the artist. This umbilicus of *Lioc. giganteum* as thus filled in does not

[1] It was not until this sheet was passing through the press that I was able to obtain and study Quenstedt's work ('Amm. Schwäbischen Jura'). *Ammonites Murchisonæ planatus* (pl. lix, figs. 16 and 17) has close resemblance to this species and its varieties. It evidently belongs to the genus *Lioceras* and should not be classed with *Murchisonæ* (*Ludwigia*) as Quenstedt has done. It differs from *Lioc. decipiens* and *simile* in having a larger umbilicus with more whorls, also in having narrower and more quadrate whorls with shorter aperture, so that, though closely allied, it is evidently not the same, but might, perhaps, eventually be conveniently classed as a variety. *Lioc. decipiens, simile,* and *intermedium,* with Quenstedt's *Am. Murchisonæ planatus,* seem to form a small, closely-allied series of smooth *Liocerata.*

agree with the umbilicus as exhibited by smaller specimens of that species and is therefore likely to mislead. A comparison of *Lioc. simile* with *Lioc. giganteum* of the same diameter, shows a much deeper, narrower, and smoother umbilicus, a more compressed ventral area, a greater thickness of section at the inner area, and the test far smoother in texture, with smaller ribs which disappear early, while it is seen that specimens of *Lioc. giganteum* carry the opposite characters throughout their growth, the ribs, especially, being visible in the later as well as in the earlier portions of the umbilicus. The umbilicus of *Lioc. simile* is certainly different to that of the large or small specimens of *Lioc. giganteum*, appearing to possess fewer coils, and not to have that somewhat excavated appearance which the umbilicus of specimens of that species has.

Between *Lioc. decipiens* and its variety *Lioc. simile* in the *Sowerbyi*-zone there exists a relationship similar to that between *Lioc. bradfordense* and its variety *Lioc. giganteum* in the *Murchisonæ*-zone, and to that, which, however, seems stronger, between the thick and thin forms of *Lioc. opalinum* in the zone of that name. Comparing the specimens from these three zones it seems not unlikely that the first were derived from the two forms of *Lioc. opalinum,* to which species they have much resemblance in smooth character of test, small umbilicus, &c., but from which they differ in the shape of ventral area and carina; while, on the other hand, the second have rather more the appearance of exaggerated forms of *Lioc. elegans*, Young (not Sowerby). In this case we have to suppose, first, the existence of links in the *Murchisonæ*-zone, and, secondly, of links in the *Jurense*- and *Opalinum*-zones which we do not at present possess. Another theory might be that *Lioc. decipiens* and *Lioc. simile* had been derived from *Lioc. opalinum* through *Lioc. bradfordense* and *Lioc. giganteum,* but then we must suppose that *Lioc. opalinum* gradually changing became ribbed and took on a different method of coiling and a different form (*bradfordense*), and that next those forms reverted to a method of coiling and ribbing similar to that at first possessed by *L. opalinum* (*decipiens*). I scarcely favour this view; but, if the former be correct, we ought to describe our specimens as *Lioc. opalinum* mut. *decipiens* and *Lioc. opalinum* mut. *simile*, or *Lioc. opalinum* mut. *sp. ?*, mut. *decipiens* or *simile*,—an innovation which, though very probably expressing the true state of the case, our present knowledge hardly warrants our adopting. It is, however, interesting to bear these conclusions in mind, for it perhaps tends to demonstrate that any attempt to class *Lioc. decipiens* and *Lioc. simile* as smooth varieties of *Lioc. bradfordense* and *Lioc. giganteum*, would be quite unadvisable.

The probable position of the specimen is the *Sowerbyi*-zone near Sherborne, but I am not able to speak with certainty. It must be a very scarce form. Plate XV, figs. 1, 2, give a very good idea of a well-preserved specimen with just the commencement of the mouth-border, and with the last of the fine ribs before it became quite smooth.

LIOCERAS DECIPIENS, *var.* INTERMEDIUM, *S. Buckman.* Plate XI, figs. 2—7.

Type.—Discoidal, somewhat compressed, carinate, whorls broad, slightly convex on the outer and slightly concave on the inner area, ornamented with somewhat indistinct sigmoidal ribs until the shell obtains the diameter of about 16 lines, and then they change to very fine sigmoidal lines of growth, with a marked curve on the middle of the lateral area. The ventral area slightly slopes and is sub-convex, carrying a distinct but by no means trenchant carina. The inner margin is concave, sloping, and shallow. The inclusion is three-fourths of the preceding whorl; the umbilicus quite regular, rather shallow, and ornamented with small ribs.

The sub-variety A is very similar, but the carina is very slightly more conspicuous; the ribs are at all times rather obscure; the whorls do not seem to increase in breadth so quickly; the umbilicus is distinctly larger and shows scarcely any ornamentation, while the inner margin is more upright. This sub-variety is also more compressed than the varietal type.

The sub-variety B is again different in many ways. The ribs are more distinct and continue until the shell attains a larger diameter; they are indistinct on the inner area; the carina is similar to that possessed by the varietal type, but the ventral area is somewhat flatter; the umbilicus is distinctly larger and shows more of the inner whorls, with small but fairly conspicuous ribs; the inner margin is more upright and the sides of the whorls are nearly parallel.

These three very peculiar forms constitute a more or less connecting link between the genus *Hyperlioceras* and the true *Liocerata.* The term *intermedium* is appropriate, for they seem to possess some of the characters of three species which occur in the same stratum with them. On looking at them all anyone can well understand the perplexity which has so frequently accompanied attempts to separate the Dorsetshire *Ammonites;* and we need not wonder at the often expressed opinion, that hybridisation among *Ammonites* was a thing of common occurrence. To my mind it seems that we have at present to deal with a genus (*Lioceras*) which, having existed for some time, became one of the dominant genera, and constantly made new efforts at variation. In time these variations would become more and more marked, and their characters more constant, until they could be fairly ranked as species. At this stage they could not be directly united together by any coeval intermediate forms, their common ancestor being the only link between them.

Lioc. intermedium, as I have said, combines some of the characters of at least three different species, and, curiously enough, two other genera. With the ventral area, carina, and general shape of *Ludwigia cornu*, the suture-line and ribbing of *Lioceras,* and the early absence of ribs, which gives them the very smooth

appearance of *Hyperlioceras*, they may be said to be intermediate in every sense. My own idea is that they really constitute a distinct species, but as I have not been able to obtain the young of *Lioc. decipiens* for comparison, I prefer to leave the matter in its present state. From *Lioc. decipiens* they may be distinguished by a larger and more ribbed umbilicus, a less compressed form, and a broader, more convex ventral area; but what further makes me incline to the idea that they may be a separate species is the fact that, although they occur at Bradford Abbas not unfrequently, I have not found one larger than is here depicted. On the other hand, *Lioc. decipiens* occurs at Sherborne, and, as far as I know, has not been found at Bradford Abbas.

From *Ludwigia cornu* these forms are separated by an entire difference in ribbing, by their extreme smoothness of test, and by greater thickness; from other species of *Lioceras* by their smoothness, quadrate appearance, and more distinct carina; from *Hyperlioceras Walkeri* by a smaller carina, and a form less compressed on the outer, but more compressed on the inner area, and a generally larger umbilicus. It must be confessed however, that the separation of *Lioceras intermedium* from the young forms of *Hyperlioceras Walkeri* is not always easy to make, and is not so definite as could be wished. One reason for this may be pointed out: the strong carina of the latter becomes much less trenchant as it approaches and reaches the body-chamber; and, if a specimen in this state be compared with a specimen of the former which lacks both the body-chamber and many of the air-chambers, there is but little difference in the amount of carina present; so that it becomes important to compare specimens which are alike but distinguishable by the absence or presence of the body-chamber.

Lioc. intermedium and most of the species of *Hyperlioceras* have been formerly quoted from Bradford Abbas under the name of *Am. læviusculus*, Sowerby; from this they may be separated by their possessing (among many points of difference) a concave inner margin and a solid carina.

The *Sowerbyi*-zone (*Concavum*-beds) at Bradford Abbas has yielded all the specimens in my collection that have their localities recorded. It is not an uncommon species, and may probably have been met with at the similar quarries at Half-Way House, Louse Hill, &c., but the matrix shows that none have come from Sherborne, nor any other parts of the district, at least within my knowledge.

Plate XI, figs. 2, 3, may be regarded as illustrating a type-form of *Lioceras intermedium*. Figs. 4, 5 show us a large-centred, more compressed, and smoother form. This is the scarcest of the series. In Figs. 6, 7 we have a more ribbed form with a larger umbilicus than in Fig. 2. All these figured specimens have come from Bradford Abbas.

In Plate XII, fig. 10, a specimen is depicted which shows us where the difficulty lies in separating this species from *Hyperlioceras Walkeri*. This

specimen, though slightly different from either, seems to be a certain extent intermediate in character, and its true position is not easy to determine. It is figured in the hope that more specimens may be collected.

Lioceras opalinum (*Reinecke*). Plate XIII, figs. 1—10.

1818. Nautilus opalinus, *Reinecke*. Maris Protog., p. 55, figs. 1, 2.
1830. ? Ammonites primordialis, *Zieten*. Verstein. Württ., pl. iv, fig. 4.[1]
1849. — opalinus, *Quenstedt*. Die Ceph., pl. vii, fig. 10.
1867. Leioceras opalinum, *Hyatt*. Bulletin Mus. Comp. Zool., vol. i, No. 5, p. 101.
? 1874. Ammonites concavus, *Dumortier*. Études pal. Bassin du Rhône iv, pl. xiii, figs. 1, 2, 3.
1874. — opalinus, *Dumortier*. Ibid., pl. xlix, figs. 14, 15, 16.
1878. Ludwigia opalina, *Bayle*. Explic. carte géol. France, pl. lxxx, figs. 1, 5, 6.
1884. Harpoceras opalinum, *Wright*. Lias Amm. Pal. Soc., pl. lxxx, figs. 6—8 (not 5, but perhaps 3).
1885. — — *E. Haug*. Beitr. Monog. Harpoceras, Neues Jahrbuch, Beil.-Bd. iii, p. 681.
1886. — — *Vacek*. Oolithe Cap San Vigilio, Abh. der k. k. geol. Reichsanstalt, Bd. xii, No. 3, pl. vi, figs. 4 and 11 only.
1886. — elegans, *Vacek* (non *Sowerby*, non *Young and Bird*). Ibid., pl. vii, fig. 17 only.
1886. Ammonites opalinus, *Quenstedt*. Amm. Schwäbischen Jura, pl. lv, figs. 1, 2, 3, 10, 12, 18 only, 22 ?, but certainly not 9, 13, 16, 20, 21, &c.
1875. *Non* Ammonites opalinus, *Lepsius*. Beiträge Juraf. Unter-Elsass, pl. ii, figs. 4, 5, which I believe to be another very different species.

Discoidal, compressed, subcarinate, whorls slightly convex, with a very small depression in the inner area, ornamented with numerous very fine sigmoidal striæ, which have a strong forward sweep on the ventral area. The ventral area in the young state slopes acutely, and possesses a small sharp carina. As the shell increases, the latter gradually lessens, and the ventral area becomes less and less acute, until at last on the body-chamber of the adult the ventral area is actually rounded (Pl. XIII, fig. 2). The inner margin is slightly concave, rather upright in the type-form except on the body-chamber. The inclusion is, as usual, slightly less

[1] This figure shows a much wider umbilicus, and the striæ very straight. It is evidently not typical, and may not be a synonym of *Lioc. opalinum*.

in the young than afterwards, when it takes up nearly the whole whorl, leaving a very narrow terrace; if the body-chamber be present the inner margin recedes[1] so that the mouth envelops about two-thirds of the preceding whorl. The termination to the body-chamber in the young consists of a lateral process,[2] probably continued until the shell reaches a nearly mature age, and which I previously thought was

FIG. 1.—Suture-line of *Lioceras opalinum*. Natural size.

continued through life; but lately the finding of several adult specimens, with the termination quite complete, has shown me conclusively that in adult age the termination is sigmoidal, slightly produced and rounded on the lateral area (the lateral horn having disappeared), and is much produced on the ventral area; and therefore these characters of the termination are quite in accordance with what we observe in the other species of this genus.

The suture-line of this species (Fig. 1), which must also be considered as the typical suture line of the genus *Lioceras*, is taken from a large specimen collected at Haresfield Hill, and is the last suture but one. It will be seen that the points that I have noticed about these sutures (p. 21), and their difference from those of *Ludwigia,* are here fully borne out, and that the sutures of *Lioc. bradfordense*

[1] This recession of the inner margin of the body-chamber from the regular line of coil is a fact to be observed in most Ammonites, but is more especially developed in certain genera. In *Lioceras* it is always very marked, and is present at all ages; and it must of course follow, for the umbilicus to obtain the small form which it exhibits when the shell is much larger, that, as the body-chamber advances and the inner chambers are formed, the inner margin gradually extends inwards and gradually takes up its proper position on the regular line of coil. As an example; that part of the inner coil now exposed, just between the inner margin of the mouth and the inner margin of the previous whorl (Pl. XIII, fig. 1), would be almost covered by the time the shell had grown another half whorl. The same holds good with specimens of all ages. This is readily seen in any series of specimens, of various ages, of a species belonging to the genus *Lioceras* which possesses the mouth-border; and it is a fact which must be especially observed in any determinations of these species, because it is quite possible to find a shell, not having the body-chamber preserved, showing a smaller umbilicus than one nearly half a whorl less in diameter possessing the body-chamber. It is most important to keep this fact well in view when tracing a form from youth to adult age; and, when measuring the umbilicus, the amount of body-chamber present must always be taken into consideration. If these points be not strictly attended to in a complex genus like *Lioceras*, with so many forms, it will lead to the confusion not only of varieties but of species.

[2] Quenstedt, 'Cephalopoda,' pl. vii, fig. 10, shows this species with lateral process complete.

(Plate IV, fig. 8), and of *Lioc. v-scriptum* (Plate IX, fig. 4), agree exactly with the suture here shown. I have found, too, that the sutures of all the species of *Lioceras* agree in a remarkably exact manner with this pattern. I shall, later on, have more to say on this point when figuring and discussing them in comparison with those of other genera. Dr. Wright, in his Monograph 'Lias Ammonites,' Plate LXXX, has mistaken the suture-line of this species, as I have pointed out in the 'Geological Magazine.'[1]

On account of the additional material which is being constantly obtained for the purpose of this work, it unfortunately cannot be avoided, that both in the plates and the letterpress, certain species are placed somewhat out of order, although in the letterpress, and as far as possible in the plates, the sub-groups will be kept to themselves.

A short time ago, at the commencement of the present year (1887), I possessed only a few small specimens of *Lioceras opalinum* from Dorset. Having now obtained a fine series from Gloucestershire, with many new features, I consider it necessary to give a further account of this species (see Dr. Wright's Monograph, loc. cit.), and thus more fully complete the series of species belonging to the genus.

It is very singular that in the Cotteswold district so much confusion should have always prevailed as to the proper characteristics of this species, and so much desire should always have been expressed to include other totally different species in this or to merge it in others. At p. 148 of his Monograph Dr. Wright regarded Lycett's *Harp. Moorei* as a variety of *Harp. opalinum;* but afterwards he figured them for comparison on the same plate, considering Lycett's species to be a synonym of Zieten's *Am. aalensis.* Dr. Lycett, too, has been quite willing to drop his own species, for in some MS. notes, which Dr. Wright quotes *in extenso* (pp. 465, 466), and which, by the kindness of Mr. W. C. Lucy, F.G.S., I have seen, he has considered it correct to place *Am. aalensis*, *Moorei*, *costula*, and other forms as synonyms of *Am. opalinus.* Several reasons may be given as contributing to form this opinion; first, the condition in which the Cotteswold Ammonites frequently occur is such as will not allow of an examination of their more minute characters; next, the number of apparently very similar forms which occur together in a thin series of strata; and especially the fact that probably the identification of one or two of the chief species has been more or less loose and incorrect. Dr. Lycett almost admits as much in his MS. notes, when he says that no specimen of *Am. opalinus* has rewarded his efforts at Frocester Hill; and none of the specimens figured by Dr. Wright as *Harpoceras aalense* appear to me to belong to Zieten's *Am. aalensis.* Probably, therefore, the argument is founded on an unsound basis. No doubt there is a perplexing number of

[1] 'The Lobe-line of certain Lias Ammonites,' S. S. Buckman, 'Geol. Mag.,' dec. iii, vol. iii, No. 10, 1886, p. 442.

forms with seemingly small differences (especially when badly preserved), but in my opinion these forms can be shown to be descended from most different sources and to possess certain constant differences both in structure and detail. To put *Am. Moorei*, *aalensis*, and *opalinus* (if correctly identified) into the same species is to ignore their true affinities, to entirely overlook the differences in their suture, the different shape and flexure of their ribs or striæ, their different mode of growth, as well as their different parentage. An attempt to unite as one species *Am. opalinus* with *Am. concavus*, Sow., or *Am. elegans*, Young, would, I think, be more reasonable, but not such a species as *Am. opalinus* with either *Am. Moorei* or *Am. aalensis*.

From nearly all the other species of the genus *Lioceras* this species is separated by an entire absence of ribs at all ages, by the possession of numerous very fine hair-like sigmoidal striæ, more prominent than mere lines of growth, and produced on the ventral area more than is usual with other species of this genus. Its small umbilicus showing portions of the inner whorls is also distinctive.

Probably considerable difficulty may be experienced in appreciating the differences which exist between *Lioceras opalinum* and *Am. elegans*, and therefore a few words to try and put the matter in as clear a light as possible may not be out of place. The first thing, however, is the correct appreciation of what *Am. elegans* really is, and on this point much confusion has existed. Sowerby was the first to figure and describe *Am. elegans*, and palæontologists have always experienced considerable difficulty in deciding what the species actually is that he so figured. As it does not come within my province to write a full account of this species, with the various views that have been adopted, I only say that I believe the specimen figured by Sowerby has a hollow carina and belongs to the true *Falciferi*, *i. e. Harpoceras falciferum*, Sow., *subplanatum*, Oppel, &c., and consequently belongs to a genus entirely different from *Lioceras*, namely, to the genus *Harpoceras restricted.*[1] Subsequently Young and Bird gave a not very intelligible figure of an Ammonite under the name *elegans*, but this is not Sowerby's species. Dr. Wright, being unable to identify Sowerby's species, retained the name *elegans*, for Young and Bird's species; and the specimen he figured on Pl. LIII, figs. 1, 2, 3, he described in his text as *Harpoceras elegans*, Young (non Sowerby). Taking this figure as really representing Young and Bird's species, I believe that it evidently differs from *Am. elegans*, Sowerby, and belongs to the genus *Lioceras;* and hence we may now retain the name. Then from *Lioceras elegans* (Young) *Lioc. opalinum* is distinguished by possessing fine striæ during the whole of its growth, by possessing a much less acute carina, and a more compressed ventral area. Probably the best distinction is the possession of fine falciform ribs by the young forms of *Lioceras*

[1] "On Jurassic Ammonites," S. S. Buckman, 'Geol. Mag.,' dec. iii, vol. iv, No. ix, 1887, p. 397. *Harpoceras* is here used only for the true *Falciferi*.

elegans. Specimens that I have from Yorkshire show these ribs very well, and they are quite different from the striæ of *Lioc. opalinum*. Vacek's *Harpoceras elegans*, which is here quoted as a synonym, does not seem to show this character, and, judging from the side view, it has the ventral area almost uncarinated like *Lioc. opalinum*. In my list of synonyms Dumortier's figures of *Am. concavus* are also quoted; but they are not the *Am. concavus* of Sowerby, as a comparison with my figure of Sowerby's original specimen will show (Pl. II, figs. 6, 7). They are generally supposed to be *Am. elegans*, but they do not show the ribbing of *Lioc. elegans* (Young), nor are they *Harpoceras elegans* (Sowerby). The shells seem to be two different forms, either closely allied to *Lioc. opalinum* or else intermediate between it and *Lioc. elegans*; in fact, they can scarcely be said to agree exactly with the types of either species, although the fine ribbing and the sectional view of fig. 3 with little carina approach more to *Lioc. opalinum* than to *Lioc. elegans*.

Besides the form of *Lioc. opalinum* which since it agrees with Reinecke's figure I consider typical (Plate XIII, figs. 4, 5, and adult, figs. 1, 2), I have met with other forms showing a slight amount of difference usually traceable from youth to adolescence in any considerable series of specimens. The most distinct is perhaps the thin form, which is rather the commoner, and differs from the type by its shallow, more open umbilicus, with very sloping walls, and in being thinner (Plate XIII, figs. 7, 8, 9, 10). Then there is the form figured in Dr. Wright's Monograph (Plate LXXX, figs. 5, 6), which is somewhat thicker than the typical form. Besides these we have certain forms, with false ribs on the inner area, connecting us with the variety *comptum*, which I will consider under that heading.

From this species I would expressly exclude certain specimens which are rather frequently met with in the Cephalopoda-bed of the Cotteswolds, and seem to very closely resemble the figure given by Lepsius previously quoted. Indeed I feel certain that, nothwithstanding their similarity in many respects, especially to the open-centred form of *Lioc. opalinum*, yet since they possess a less complex suture-line with practically only one small auxiliary lobe, they really belong not only to another species but to another genus. When closely compared with *Lioc. opalinum* they are seen to have straighter ribs on the lateral area (ribs and not striæ as in the case of *Lioc. opalinum*), and also to possess a more prominent and trenchant carina. The width of the umbilicus, with its rather upright walls, is at all ages considerably in excess of that shown in the open *Lioc. opalinum*. I cannot help thinking that it is this species having a close affinity to *Grammoceras Moorei* (Lycett), that has partly given rise to the opinion of that species being only a variety of *Lioc. opalinum*.

The absence almost of even a sub-carina in *Lioc. opalinum*, except in the young state, and the rounded character of the ventral area (all trace of keel being lost),

when the body-chamber is present (Pl. XIII, fig. 2), cannot be said to be quite the rule in the *Liocerata*, though some old specimens of other species exhibit a tendency this way. It is most certainly a feature in *Oppelia*, and is worthy of notice in that connection.[1]

When treating of the genus *Lioceras* I have stated my reasons for choosing this species as the type of the genus in preference to any of the other species which Hyatt placed in it, and etymologically this name applies to the species very well.[2] The specific name was probably given by Reinecke on account of the opalescent tints sometimes seen on the inner coat of the test.

I have collected *Lioc. opalinum* at Haresfield Hill,[3] in bed No. 15 (p. 43), plentifully, well-preserved, and of large size, with the mouth-border complete (Pl. XIII, fig. 3). In bed No. 16 I have found it of smaller size and not so frequently. I have obtained it from the same horizons at Frocester Hill; and the same remarks as to size and position apply to beds Nos. 4 and 5 of the Coaley Wood Section. From North Nibley I have some small specimens from bed No. 6, and the late Mr. E. Witchell, F.G.S., showed me some specimens which he had obtained at Little Sodbury, near Yate. I do not know of its occurrence in Somerset, though it is probable that its real bed occurs at the bottom of some of the quarries at Haselbury, Misterton, &c., but has been overlooked. In Dorset Burton-Bradstock Cliff is the chief locality, whence I have many specimens, but none over three inches in diameter. From Stoke Knap I have it; but it is very scarce. I have not seen it from the Sherborne and Bradford-Abbas side of the County, and it is probable that the whole zone is entirely absent. Through the kindness of Mr. E. A. Walford, F.G.S., I have seen some specimens from Otley Hill, near Hook Norton, North Oxfordshire (p. 52); and by the kindness of Mr. B. Thompson, F.G.S., a specimen from New Duston, Northamptonshire (p. 48), with specimens of *Lioceras comptum* (Reinecke).

Plate XIII, figs. 1, 2, show a large typical specimen of this species, the test of which is extremely well preserved. In fig. 2 the rounded ventral area of the body-chamber is noticeable; and, as the ventral area is well-preserved and has the test present, there can be no mistake about it. In Fig. 3 we have a portion of a large specimen, five and a half inches in diameter, with the mouth-border, while what this is in youth is partly indicated in fig. 12. These specimens came from Haresfield Hill, Gloucestershire, from the bed No. 15 in the section at p. 43. Figs. 4, 5, illustrate a smaller typical specimen, of a size to compare with Reinecke's

[1] I do not, however, consider that *Oppelia* is descended from *Lioc. opalinum*, because I think that in *Am. discoides*, Zieten, we have one of the earliest forms of *Oppelia-like* species. *Am. discoides* occurs just below *Lioc. opalinum*.

[2] λεῖος, smooth ; κερὰς, horn.

[3] Marked as Standish Beacon on the Ordnance Survey Map.

original figure. This specimen came from bed No. 5 of the Coaley-Wood section (p. 45). Fig. 6 is a very small specimen of the typical form, for comparison with fig. 11, and indicating that the typical form is constant in its ornamentation throughout life. This specimen is from Burton Bradstock, Dorset. Figs. 7, 8, give a variety, slightly thinner and having a considerably larger umbilicus. This form is rather the commonest of all. In Fig. 8 is indicated the outer portion of the ventral area on the top of the figure, peculiarly compressed, probably due in part to absence of test. Figs. 9, 10, illustrate a younger form of this kind. In figs. 7 and 9 the peculiar, much sloped inner margin, which gives the specimens a singular appearance, is scarcely brought out. These specimens are from Haresfield Hill, bed No. 15. The fig. 1 at p. 36 displays the suture-line of this species; it was taken from a large adult specimen, and must be considered as typical for the genus *Lioceras*.

Lioceras opalinum is an Ammonite which has given its name to a certain zone or series of strata lying between the *Jurense*-zone below and *Murchisonæ*-zone above; and this horizon with the beds below, the *Sands* especially, down to the Upper Lias Clay, has caused much debate whether it should be classed with the Lias or the Oolite. At pages 2—5 I have given a few notes upon the subject, and the opinions of some authors; but, as I had not then seen the sections in Gloucestershire where this zone is exposed, and had only been able to obtain an imperfect view of those in Dorset, I purposely refrained from giving any opinion as to the desirability of classing the *Opalinum*-zone with the Lias as Dr. Wright had done, or with the Inferior Oolite (or at any rate distinct from the Lias) as most other authors have been inclined to do. Since, however, I have had opportunities of thoroughly examining the Gloucestershire sections at Frocester, Coaley Wood, Cam Down, &c., and especially at Haresfield Hill, I have come to the conclusion that the sections in Gloucestershire furnish no reason at all for classing the *Opalinum*-zone otherwise than in accordance with what has been, I believe, the usual custom, namely, as distinct from the Lias. Dr. Wright, at p. 148 of his 'Monograph on the Lias Ammonites,' gives "a thin band of hard ferruginous marl" as the *Opalinum*-zone at Haresfield, and states that he had found a piece of rock which, itself containing Inferior-Oolite fossils, had on its *underside* an impression of *Harp. opalinum*. Since, however, I have found most of my specimens of this species *in* this rock I cannot do better than clearly point out the position which *Lioceras opalinum* occupies. The following sections not only show the relationship of the *Opalinum*-zone to the beds above it, but also, through the Sands to the Upper Lias Clay below; and, since we shall have to discuss several species of

Ammonites which occur in these beds, their insertion here in their sequence will be useful.

It will be seen that *Lioc. opalinum* occurs only sparingly, and of small size, in the top of what has generally been called the Gloucestershire Cephalopoda-bed[1] (or rather well up in Bed 16, Haresfield), but that it is most abundant and of largest size (five and a half inches in diameter) in the hard rock above, that is, exactly in the position where Quenstedt states it should come.[2] It is this rock, a foot or so thick, very hard, emitting a metallic ring when struck, that Dr. Wright must have considered to be Inferior Oolite, while placing the beds below in the Upper Lias, because this rock could not in any way be called a "thin band of hard ferruginous marl" a description which does apply to the beds below. Dr. Wright's statement seems to mean that *Lioc. opalinum* occurred in the thin band of marl even so high up as to leave its impression on the rock above, but, as it did not occur in the rock itself, here was the dividing line between the *Opalinum*- and *Murchisonæ*-zones, and therefore between the Lias and Oolite. The majority, however, and the best developed of my specimens of *Lioc. opalinum* have been obtained from this hard rock above the so-called "Cephalopoda-bed." The hard rock must, therefore, be considered to belong to the *Opalinum*-zone, and, by Dr. Wright's system, that means to the Lias. He, however, considered it Inferior Oolite, in which opinion I fancy he would meet with full support. The *Opalinum*-zone must then be considered to be in the Inferior Oolite and not in the Lias, and the line of division between the Lias and the Oolite must be drawn at any rate *below* this zone. How much higher than Bed 15 the *Opalinum*-zone may be considered to range, or how much more would have to be placed in the Lias if the zone were to stand part of that formation, is certainly a question not easily to be determined by the very scanty fauna (especially *Ammonites*) that has been obtained from the beds above. The zone may or may not include the "Sandy Ferruginous" beds,[3] D′, and the same may be said of the "Lower Limestone" series, D″, but we know that it does not include the Pea-grit proper, which belongs, without doubt, to the *Murchisonæ*-zone.

[1] The Cephalopoda-bed is considered to be the soft friable marl (beds 17, 18, 19, and perhaps part of 16, section V). Dr. Lycett, 'Cotteswold Hills,' p. 20, says of it, "Its thickness at Haresfield Hill is not more than two feet, its colour is dark or chocolate-like, and it is so little compacted that it may be broken up by the hands alone."

[2] Compare Lycett, 'Cotteswold Hills,' p. 27, and corrigenda, p. 164; also p. 163.

[3] See 'On the Pisolite and Basement-beds of the Inferior Oolite of the Cotteswolds,' by E. Witchell, Esq., F.G.S.

V. *Generalised Section of the Escarpment of Haresfield Hill (six miles due south of Gloucester.)*

			Ft.	In.
Pea-Grit Series of Leckhampton.	E 1.	Rubbly, whitish limestone with numerous flattened and irregular-shaped pisolitic grains. *Rhynchonella subangulata*, Dav., *Rh. oolitica*, Dav. (abundant), *Terebratula sub-maxillata*, Dav., *Tereb. plicata*, J. Buckm., *Tereb. pisolitica*, S. Buckm.	5	0
Lower Limestone of Mr. Witchell.	D″ 2.	Several beds of limestone, varying in colour from white to pale brown, with numerous very fine, round, oolite grains; discoloured in places with iron. Sometimes containing, especially towards the upper part, fragments of shells and some coarser grains. Worked for rough masonry. At the base, but not separable, is an extremely shelly bed, about one foot thick, with numerous fragments of shells, *Pentacrinites, Oysters, Polyzoa, spines of Cidaris,* &c. about	25	0
	3.	Dark brown sandy bed with some grey pebbles occasionally embedded	0	3
	4.	Blocks of limestone similar to No. 2, if anything somewhat finer in texture; discoloured a good deal with iron; containing sometimes small fragments of shells, and small, brown, irregular-shaped, decomposed grains. Bored in places by Annelids. Worked for rough masonry	10	0
	5.	Grey limestone with some few irregular grains; not generally worked	2	3
	6.	Hard grey limestone with no oolite grains;[1] a few iron stains	0	6
	7.	Soft, brown, gritty, sandy bed, without any oolite grains	0	9
Ferruginous Beds (Witchell.)	D′ 8.[2]	Compact grey limestone with coarse oolite grains, which are absent in the upper part; very little stained with iron	2	0
	9.	Similar bed with somewhat finer grains, and rather more stained	1	0
	10.	Grey limestone with numerous brown grains, and many ferruginous patches. Much broken up, readily disintegrated by weather, and very brown when exposed. *Lioceras ambiguum ?* poorly preserved	0	7
	11.	Grey limestone with numerous irregular-shaped grains	1	0
	12.	Grey limestone with numerous light grains and ferruginous patches	1	6
	13.	Rubbly parting	0	2
	14.	Grey limestone with numerous ferruginous patches and somewhat coarse grains	1	5
Opalinum zone.	C‴ 15.	Very hard limestone, varying in colour from a light greyish-yellow to a dark brown, with almost an approach to chestnut, containing very numerous and very small dark-brown grains. This stone is generally browner in patches where the fossils occur. Its generally rich colour gives it a totally different appearance to any of the other beds above or below. *Lioceras opalinum* abundant and of large size; *Lioc. comptum*	1	0

[1] That is, to the naked eye in this and other cases.

[2] Beds 8—14 are all very similar in character, and probably scarcely separable except that some are more readily decomposed by weather. When freshly broken up they are of an iron-grey colour, but soon became very brown on exposure, and hence when weathered are quite different in appearance from those above them. These beds contain grains of mica.

			Ft. In.
	16.[1]	Hardish, less compact, yellow rock (softer below), with irony grains; very closely attached to bed 15. *Lioc. opalinum*, small size; *Gramm. aalense*, Ziet.; *Trigonia Ramsayi*, Lyc.	0 4
	C″ 17.	Yellow, softer, easily broken marl, with dark brown grains. *Rhynchonella cynocephala*, Rich., *Gramm. Moorei*, Lyc.; *Lytoceras Wrighti*, S. Buckman,[2] occurs in this bed and the bottom of the one above .	0 6
	18.	Dark brown seam with *Rhynch. cynocephala* abundant . .	0 1–2
Striatulum subzone.	C′ 19.	Yellowish-brown marl, similar to No. 17, containing at the base a line of nodules embedded in it at irregular intervals. These nodules are similar to the stone occurring in the sands below, viz. bluish-grey, hard, sandy, micaceous stone, with no ferruginous grains. *Tereb. haresfieldensis*, Dav., occurs frequently throughout this bed, but more commonly just above the nodules. *Gramm. striatulum*, Sow., occurs in fragments[3]	0 10
Cotteswold Sands.	B 20.	Greyish-yellow micaceous sands, extending down the hill perhaps 100 feet. They are not exposed except in very small openings, and a few feet at the top. About thirty feet from the bottom, from a band of sandy stone, fragments of a variety of *Hildoceras bifrons* were obtained . .	100 ? 0
	A 21.	Upper Lias Clay ?	

[1] Beds 17, 18, 19, and perhaps part of 16, are the Gloucestershire Cephalopoda-bed of various authors. Dr. Wright drew the line between Lias and Oolite either between 15 and 16 or 16 and 17. There is no lithological break between beds 15—19, except perhaps 18. They almost pass one into another. Bed 15, Mr. Witchell told me, he probably included in his Sandy Ferruginous Limestones.

[2] *Lytoceras Wrighti*, new species, figured by Wright as *Lytoceras jurense*, 'Monog. Lias Ammonites,' pl. 79, 1884, but not the species so named by Zieten.

[3] At Frocester Hill (called Coaley Peak in the Ordnance Survey Map) the well-known quarry does not show the whole of the beds so well, and one has now to obtain additional information from exposures in the near neighbourhood. The beds equivalent to 15, 16, 17, at Haresfield, both in lithology and palæontology, present exactly the same features except that the divisions between them are more marked. Between 15 and 16 the difference in lithology is very striking on a smooth face, and between 16 and 17 a slight band of marl is perceptible. The dark seam (18) does not contain *Rhynch. cynocephala* in noticeable abundance, it varies from 2—3 inches, and is certainly not persistent, as one exposure in the quarry does not show it at all, while the other a few yards beyond does so plainly. The bed below is considerably thicker than at Haresfield (19), being three feet. It is in a rather more marly condition than the bed above the seam, and contains *Tereb. haresfieldensis* in abundance, especially about the middle. Sometimes it inclines to a blue colour. Towards the lower part, which, however, I could not see well, a very dark bed occurs similar in character to bed 8 at Coaley and bed 14 at Nibley. At its base, and resting on the yellow sands, a line of blue-hearted sandy nodules is situated. (The yellow sands probably extend about 150 feet down the hill, but present no sections.) The above fossiliferous beds are very rich, especially in the upper part. *Lioceras opalinum* occurs exactly as at Haresfield. *Lytoceras Wrighti* occurs rather frequently and of large size in the beds equal to 16 and 17, both on the dark seam and at top of 16, and I have collected it and *Lytoceras opalinum* as close together as possible in the same lump of rock.

VI.—*Section exhibited at Coaley Wood (twelve miles from Gloucester south by west).*

Zone		Bed	Ft.	In.
		1. Large freestone quarry, above which are seen beds with *Terebratula globata* . . . . . . about	50	0
	D′	2. Portion unseen.		
		3. Pale yellow stone with light coloured oolitic grains . . about	5	6
Opalinum zone.	C‴	4. Very hard, pale coloured, compact rock, with very small brown grains. Gives a metallic ring when struck. *Lioc. opalinum* fairly abundant; hardly any other fossils	1	4
		5.[1] Hardish oolitic rock, somewhat irregular, not so compact, yellow coloured, with more brown grains. *Lioc. opalinum*, small *Chemnitzia*, *Belemnites*, &c.	0	6
Striatulum subzone.	C″	6. Rubbly oolitic irregular stone like 5, hardly separated from it, but softer, and mixed with marl. *Am. torulosus?* quantity of *Belemnites* and *Astarte*, also *Opis*, *Cypricardia*, and many other *Lamellibranchiata*. *Lytoceras Wrighti*, S. Buckm., occurs in this bed and the bottom of No. 5	0	8
		7. Hard, compact, whitish-yellow stone, with darker grains. *Gramm. fallaciosum?*,[2] Bayle; *Oxynoticeras? discoides*, Zieten; *Hammatoceras insigne?* Schubler	0	6
		8. A seam of brown rubbly marl, with numerous dark brown oolite grains; looks like crushed linseed. *Gramm. striatulum*, Sow.; *Gramm. radians*, Wright (pl. lxiv, fig. 1)	0	7
Cotteswold Sands. Variabilis subzone.	B″	9. Very hard, bluish-grey, sandy nodules, embedded in a marly paste like No. 8, of which it is really a part. *Gramm. striatulum* occurs sometimes in the paste *on* the nodules, but never *in* them to my knowledge .	0	2–3
		10. Hard, blue-centred stone	0	6
		11. Fine, yellow, micaceous sands . . . . about	50	0
		12. Brownish concretionary rock, very slightly micaceous, containing dark oolitic grains and pieces of broken shells, has a similar appearance to bed 7, but harder. Some *Ammonites*, but scarce . . .	2	9
		13. Two bands of hard yellowish-blue stone, somewhat sandy. Large *Limæ*; *Ammonites*, &c.	2	0
		14. Yellow sands, becoming blue in the lower part . . .	10	0
		15. Dark, yellowish-brown, concretionary marl with *Ammonites* . .	0	3
		16. Band of yellowish-blue, hard sandy stone. *Ammonites* fairly abundant, especially on the top; *Haugia*[3] *variabilis*, d'Orb., and similar forms. *Lytoceras sublineatum*, Oppel; *Stephanoceras*, sp.? . .	0	9
		Fine yellow sands . . . . . about	25	0
Zone?	B′	17. Band of yellowish-blue hard sandstone, with *Hildoceras bifrons*,[4] Brug. abundant; *Harp.? compactile*, Simpson	1	0

[1] Beds 5—8, Cephalopoda-bed of various authors.

[2] The identification of some of these *Ammonites* not yet freed from matrix must be considered provisional for the present. They will be alluded to later on in their right order.

[3] *Haugia*, nov. gen., in compliment to Dr. E. Haug, of Strasburg; type *Am. variabilis*, d'Orbigny, Ceph., pl. 113, figs. 1, 2.

[4] This is a much compressed involute variety, and very different to what I have from the Upper Lias Clay of Somerset.

			Ft.	In.
		18. Yellow sands visible for some feet, and conjectured to extend down to the spring of water	40	0
	A	19. Upper Lias Clay ?		

VII.—*Section of Nibley Knoll* (*fifteen miles from Gloucester south by west*).

			Ft.	In.
Parkinsoni zone.		1. TRIGONIA-GRIT and rubble	5	0
		2. Pale-coloured freestone with oolitic grains not coloured with iron; with dark brown bands occasionally	25	0
		3. Freestone imperfectly shown . . . about	10	0
	D′ ?	4. Pale, somewhat sandy rock, very slightly oolitic; imperfectly shown. *Pholodamya fidicula*, *Trigonia striata*, *Astarte* . . about	8	0
Opalinum zone.	C‴	5. Band of pale, slightly oolitic rock, irony grains	1	2
		6. Light yellow rubbly marl with irony grains. *Lioc. opalinum*, Rein.	0	9
	C″	7. Band of rock. *Rh. cynocephala*, Rich.	0	8
		8. Yellowish-grey clayey marl	1	0
		9. Yellow marl, oolitic, somewhat concretionary	1	2
		10. Yellow and yellowish-grey marly shales, many dark oolitic grains	3	6
		11. More concretionary marls with *Ammonites*	2	6
		12. Much the same as 10	2	0
Striatulum subzone.	C′	13. Hardish yellow oolitic rock. *Gramm. striatulum*, Sow.; *Hamm. insigne*, Schubler	1	0
		14. Dark brown oolitic paste; looks like crushed linseed. *Gramm. radians*, Wright (pl. lxiv, fig. 1)	0	7
		15. Hard, irregular rock, in two layers. *Gramm. striatulum* abundant; *Lytoceras* (of the *jurense* group)	1	2
Cotteswold Sands. Variabilis subzone.	B″	16. Fine yellow sands, harder at the top. Perhaps divided by concretionary layers, but none such visible . . . . about	60	0
		17. Yellowish-brown, concretionary, sandy layer; no fossils	0	9
		18. Hard, bluish-yellow, slightly sandy rock, with *Belemnites*, *Turbo*, *Amberleya*, *Lima*, &c.	0	7
		19. Fine yellow sands	0	10
		20. Yellow sandy stone; only one species of *Ammonite*, which is small and fairly abundant	0	6
		21. Yellow sands	5	0
		22. Band of yellow sandy stone	0	4
		23. Yellow sands	3	0
		24. Band of yellow sandy stone	0	7
		25. Yellow sands	7	0
		26. Band of yellow sandy stone	0	4
		27. Yellow sands	3	6
		28. Band of blue-centred sandy stone, not well exposed. *Harp. ? compactile*, Simpson; *Stephanoceras*, *Belemnites*, &c.	0	6
		29. Yellow sands	6	0
		30. Band of blue-centred sandy stone. *Lytoceras sublineatum*, Oppel; *Harp. ? compactile*, Simps.; *Haugia Ogerieni ?* Dum.; *Stephanoceras*, &c.	0	6

		Ft.	In.
	31. Blue and yellow sands, continuing down probably to where water is obtained in the village	30–35	0
A.	32. Upper Lias Clay?		

VIII.—*Section exhibited in the road at Stinchcombe (thirteen and a half miles from Gloucester south-south-west).*

This shows the junction of the *Cotteswold Sands* with the *Upper Lias Clay*, thus giving particulars which the other sections do not. As this section is about two miles north of Nibley it may well be taken as showing the base of those Sands exhibited in the last section.

Cotteswold Sands.	1. Yellow sands which break up in small rectangular lumps, extending up the hill		
	2. Very dark brown argillaceous marl, containing *Hildoceras bifrons*, Brug., in abundance; *Harp.? compactile*, Simps.; *Belemnites*, &c. . .	0	1
	3. Brownish and sometimes bluish, shelly, somewhat sandy stone, with plenty of small ferruginous specks (top part very uneven and filled with the bed above). *Hild. bifrons*, *Stephanoceras*, *Rhynchonella*, *Terebratula*, &c.	0	8
Upp. Lias Clay. A.	4. Dark blue clay without fossils, containing large blue-hearted nodules of stone, which break with a conchoidal fracture and are non-oolitic .		

IX.—*Section at Burton-Bradstock Cliff, Dorset, partly taken from Mr. Hudleston's 'Gasteropoda,' Pal. Soc. (vol. for year* 1886, *p.* 31).

	"1. Line of irony nodules, Gasteropoda, *Am. Murchisonæ* . .	1	9
	2. Impure limestone with few fossils	1	6
C′.	3. Brash and rock with *Am. opalinus*, Gasteropoda . . .	0	3
C″.	4. Calciferous grits and brown sand-rock of the Yeovil Sands." ["Above the main mass of the 'Yeovil Sands' there occur about seven feet of sand-rock and calciferous grits between two lines of very thin, smooth, sharply-keeled Ammonites (op. cit., page 30)."] . . .	7	0
B.	5. Main mass of Yeovil Sands extending, as I know, to a depth of 150 or 200 feet, and containing concretionary nodules, and, in other places, if not here, shelly beds		
	6. Upper Lias Clay containing, in other places near, *Hild. bifrons* and other characteristic *Ammonites*		

Part of a General Section of the Oolitic Beds in the Northampton District, extracted from a paper[1] *by the late Mr. S. Sharp, F.G.S., &c., p.* 358.

GREAT OOLITE.

Line of unconformity.

1. White or grey sand, more or less coherent, and with occasional ferruginous stains, sometimes quarried for building stone. A plant bed is usually found in this sand	12	0

[1] "The Oolites of Northamptonshire," 'Quart. Journ. Geol. Soc.,' vol. xxvi, 1870, pp. 354—391 See this for further details.

		Ft.	In.
Northampton Sand. Inferior Oolite.	2. A series of very variable beds, composed sometimes of ferruginous sandstone in thin layers which overlie calcareous beds containing shelly zones, false-bedding being frequent; sometimes the whole section consists of calcareous rock with false-bedding, sometimes it presents a series of beds of compact ferruginous sandstone, with no fossils. In one instance, the entire section consists of white sand and sandstone, with no fossils	30	0
	2 *a*. Coarse oolitic, or subcrystalline limestone with fossils, overlying a calcareo-arenaceous slate like Collyweston Slate . . .	4	0
	3. Beds, chiefly consisting of ironstone, containing *Rhynchonella variabilis*, and *R. cynocephala;* and *Ammonites bifrons*[1] at the base . .	35	0
	Upper Lias Clay.		

Part of the Beds No. 3 in the above section are more fully given by Mr. Sharpe at p. 370, as below.

Part of Section of Old Duston Stonepit, using Quarrymen's Terms.

		Ft.	In.
	1. "The Yellow" building stone, consisting of six or seven beds of varying thickness, in two divisions, differing somewhat in tone of colour. These beds contain "pot-lids" of ironstone; also *Cardium cognatum*, &c. .	6–7	0
	2. "Best Brown Hard" building stone in three or four beds,—a coarser, stronger stone than that of the other beds, but of a rich red-brown colour; it contains few fossils	6	0
C‴	3. "Rough Rag," a slightly calcareous sandstone, green-hearted, hard, and durable, used for copings, gravestones, and buildings. It contains *Ammonites Murchisonæ*,[2] *A. opalinus*, *Nautilus*, *Ceromya bajociana*, *Pholadomya fidicula*, *Cardium cognatum*, *Cucullæa*, &c., and a characteristic zone of *Astarte elegans*	3	0
	4. "Hard Blue," a very hard blue-hearted stone, the surfaces of the joints and bedding brown from oxidation. It contains the same fossils as the last bed excepting *Ammonites Murchisonæ* and the *Astarte elegans* zone	3–4	0
	5. The presence of water prevents the working of the stone in this pit to a lower depth, but in an old disused pit in an adjoining field the beds for about three feet lower are exposed, and these consist of cellular ironstone, having sometimes green arenaceous, and sometimes ochreous cores .	3	0

[1] The occurrence of *Am. bifrons* is interesting to note when compared with the foregoing sections of the Cotteswold Sands in Gloucestershire, Nos. V, VI, VIII. Mr. Thompson thinks the specimens have come from Upper Lias nodules; but this is not the case in the Cotteswolds.

[2] It must be understood that the list of species here given are merely copied from Mr. Sharpe's paper, and rest on his authority.

An analysis of the Cotteswold sections shows us that, while the beds which actually contain *Lioc. opalinum* do not vary so very greatly, yet the thickness of what is called the Cephalopoda-bed increases very much at North Nibley. This we see chiefly occurs in the middle part, or the beds lying between those below in which I have noted *Gramm. striatulum* and those above with *Lioc. opalinum*, and there is also a certain increase in the beds with *Gramm. striatulum*. Calling these horizons C‴, C″, C′, the result may be stated in a tabular form, thus :

	Haresfield. Ft. In.		Coaley Wood. Ft. In.		North Nibley. Ft. In.
C‴	1 4	...	1 10	...	1 11
C″	0 8	...	0 8	...	10 10
C′	0 10	...	1 1	...	2 9
Total ...	2 10	...	3 7	...	15 6[1]

C‴, as I have said, are the beds where *Lioc. opalinum* actually occurs in the Cotteswolds, while C″ are the beds below, in which I have not detected it though I have found in them a somewhat similar, but I believe generically different, *Ammonite*. If we use the name "*Zone of Am. opalinus*" it would seem correct to place C‴ and C″ in that zone, and, as I have previously remarked, the upward extension of the zone is a matter of uncertainty. It is, however, well to consider that Oppel[2] makes two zones, the one of *Trigonia navis* and the other of *Am. torulosus*, and states that *Am. opalinus* occurs throughout both zones (pp. 297, 367). Perhaps C″ and part of the "Sandy Ferruginous" beds D′ may be respectively the zones of *Am. torulosus* and *Trigonia navis*, and C‴ should be parted between them. C′, or the lower part of the Cephalopoda-bed in Gloucestershire, I have provisionally called the *Striatulum*-subzone because of the presence of *Ammonites striatulus* so abundantly in the beds which directly overlie the yellow micaceous Cotteswold Sands that are lithologically so different. From Haresfield Beacon to Little Sodbury, a distance of nearly seventeen miles direct, I have found this *Ammonite* always in this position. Oppel,[3] when treating of Frocester Hill, places beds of this horizon (*i. e.* lying on the top of the Yellow Sands) in the zone of *Am. jurensis*, a species which has hitherto, I think, been

[1] This is the greatest development of the "Cephalopoda-bed" which I know, viz. fifteen feet six inches. Dr. Wright, on the authority of Sir A. C. Ramsay, states ('Monogr. Lias Ammon.,' p. 95) that at Wotton-under-Edge the series is sixteen feet thick. With my late friend Mr. E. Witchell I tested this point by actual measurement, and found it to be only eleven feet. In other respects the section agrees with North Nibley.

[2] Oppel, 'Juraformation,' pp. 293 and 305; and at p. 321 he states that these two zones sometimes attain a thickness of 300 feet in the Swabian Alps.

[3] Oppel, *op. cit.*, p. 296.

incorrectly identified (so far as British figures are concerned), and which I have not yet obtained. Its claim to rank as a British species being somewhat doubtful, and the actual extent of the beds which may be equivalent to the Continental "*Zone of Am. jurensis*" being uncertain, I have preferred to use the term "*Striatulum*-subzone" to denote the beds which in the Cotteswolds overlie the Yellow Sands and form the lower part of the Cephalopoda-bed. When thoroughly developed the subzone consists of two or more bands of hard stone with a dark brown marly layer between, and contains certain characteristic *Ammonites*, among which is *Gramm. striatulum* (p. 46).

The thickness of the Cotteswold Sands in the Gloucestershire sections is of necessity partly an estimate which gives them an average of 100—125 feet at these localities. Oppel[1] places these sands at Frocester in the upper part of the zone of *Posidonomya Bronni*, the "hard blue beds with *Am. bifrons* and *Am. serpentinus*" forming the lower portion. I have preferred to distinguish for the present their greater portion at least as the *Variabilis*-subzone, since this *Ammonite* occurs in almost the first fossiliferous band below the *Striatulum*-beds. But the presence of *Hildoceras bifrons* abundantly in these sands at least forty feet from their base,[2] and also at the base itself above the blue clay,[3] makes it extremely hard to draw any line of demarcation between the *Variabilis*-subzone and the zone of *Hild. bifrons*. H. B. Woodward,[4] using the term "Midford Sands" in its widest sense to include the Yeovil and Cotteswold Sands as well as those at Midford, states that they contain the zones of *Am. opalinus* and *Am. jurensis*,[5] and places the whole series in the Lower Oolites away from the Lias; but, as regards the latter, this occurrence of *Hildoceras bifrons* must be somewhat hard to explain. These sands, by whatever name they are called, are very puzzling to correlate with any degree of certainty; and I feel some doubts about the propriety of using the term "Midford Sands" for the whole series in the three counties of Dorset, Somerset, and Gloucester until we have obtained further

[1] Oppel, *op. cit.*, p. 296.

[2] Sections V, VI.

[3] Section VIII.

[4] 'Geology of England and Wales,' 2nd edition, p. 285, 1887.

[5] I expressed this opinion with regard to the zones of the Yeovil Sands ("Amm. Inf. Ool," 'Quart. Journ. Geol. Soc.,' vol. xxxvii, p. 608, 1881), and Oppel's statement that at Ilminster the Sands of the Inferior Oolite begin above a bed filled with *Am. jurensis, radians, variabilis,* &c., partly helped to form it ('Juraf.,' p. 253). Now I know that my determination of *Lytoc. jurense* was incorrect, and having since seen the much clearer exposures of the Cotteswold Sands and Cephalopoda-bed, both containing a far better Ammonite fauna, I feel considerable doubts about the matter, and shall be far from satisfied about the correlation of the Yeovil Sands with the Cotteswold Sands and Cephalopoda-bed without working the subject up more fully in Dorset. The general identity of the deposits is probable, but their exact correlation is the difficulty.

knowledge. According to Oppel neither the zone of *Jurensis* nor of *Opalinus* occurs in the Cotteswold Sands. He places the lower part of the Cephalopoda-bed in the zone of *Am. jurensis*, and he claims the Sands as the upper part of the zone of *Posidonomya Bronni*.

If the term "Midford Sands" is to include the *Opalinum*-zone, it must be taken to be equivalent not to the Cotteswold Sands alone but to the Cephalopoda-bed as well, and may in that case even include a considerable part of the "Sandy Ferruginous" beds, which would be an anomalous state of things. According to Mr. Hudleston[1] there is no trace of the fauna of the Cephalopoda-bed of Gloucestershire in the Midford Sands themselves at Midford, and therefore I think that it would be unwise to use the term so as to include that deposit. My idea would rather be to place some name on the Sands occurring in the three Counties that would signify the horizon equivalent only to what lies between the Upper Lias Clays below and the *Striatulum*-beds above, equal in fact to the Cotteswold Sands, but not to include the lithologically very different strata of the Gloucestershire Cephalopoda-bed in the term *Sands*. It may be that the Midford Sands are equivalent either to the Cotteswold Sands only, or to those Sands and more. In the former case the term would do, but the proper zonal constituents would have to be determined; in the latter case I think that it would be preferable to use some other name to indicate the Sands alone in other counties.[2]

As will be seen from the extract from Mr. Hudleston's section given at p. 47, a bed only three inches thick containing *Lioc. opalinum* occurs at the base of the Inferior Oolite Limestone at Burton Bradstock. This bed I take to be the exact equivalent of the one at Haresfield, above the Cephalopoda-bed, viz. No. 15, and there are at Burton Bradstock some seven feet of sandy grits just underneath, which must be reckoned to the lower part of the *Opalinum*-zone, and from which probably my specimens of *Lytoceras torulosum*, Schübler, were obtained. A similar position is occupied by the sandy marls and sandstone beds which occur at Stoke Knap near Broad Windsor, Dorset, near Haselbury, Somerset, and at some other places, and which are from two to five feet thick. They are, I imagine, below the actual bed with *Lioc. opalinum* at Burton Bradstock, but are the equivalent of the beds Nos. 17 and 18, at Haresfield, and therefore, like those,

[1] 'Gasteropoda,' Pal. Soc., volume for the year 1886, p. 56.

[2] Having visited Midford since I wrote the above, and finding that the *Parkinsoni*-zone there rests directly upon yellow sands, I prefer to consider all the intervening beds to be absent, and to imagine these sands to be the equivalent of those below the *Striatulum*-beds in Gloucestershire, rather than as doubtful representatives of the lower members of the Inferior Oolite. In that case the sands at Midford do not contain the zone of *Am. opalinus*, and, according to Oppel's opinion about the Cotteswold Sands, they would be below the zone of *Am. jurensis*. If Oppel is right, their inclusion in the Inferior Oolite is a mistake.

are best classed as the lower part of the *Opalinum*-zone. Among other things, I have obtained from them *Lytoc. torulosum*, *Terebratula infra-oolitica*, and *Rhynchonella cynocephala*. The last-named fossil occurs abundantly with some other *Rhynchonellæ*, *Waldheimiæ*, *Grammocerata*, and very rarely *Lioc. opalinum*. I am inclined to think that the Freestone-beds of Ham Hill containing *Rhynchonella cynocephala* are upon the horizon of this *Opalinum*-zone taken, as above, in a wide sense.

The identity of the Yeovil Sands *below* this horizon with the similar sands of the Cotteswolds appears probable, the fauna of what I call the *Striatulum-sub-zone* in Gloucestershire seeming to be entirely absent. Therefore it is probable that the whole of this part of the Yeovil Sands,[1] their "main mass," would be *below* the zone of *Am. jurensis* according to Oppel. But, notwithstanding their apparent identity with the Cotteswold Sands, we do not find in the shelly bands the extensive Ammonite fauna which we meet with in those bands in the Cotteswolds. In fact, I do not think that the fossiliferous bands in the two series contain an *Ammonite* in common. The Yeovil Sands contain one having a very great resemblance to *Gramm. Moorei*, Lycett, an *Ammonite* which in Gloucestershire is characteristic of the middle part of the Cephalopoda-bed C″, and of which I have seen no trace in the Cotteswold Sands. The fact is that, looking at the *Ammonite* fauna, the Cotteswold Sands are extremely well stocked, and there should be little question of their true position when these *Ammonites* have been worked out. The Sands at Midford and in Dorset are not at all well-furnished in this way, and hence the trouble that we experience. This state of things is exactly reversed when we compare the Inferior-Oolite Limestone of Dorset and Gloucestershire.

The bed which I have numbered "3" in my extract from Mr. Sharpe's section of the Northampton Sand at Old Duston is the one from which he quotes *Am. opalinus*, and this is also confirmed by Mr. B. Thompson, F.G.S., who has sent me specimens of *Lioceras opalinum* and *Lioceras comptum*, from this horizon at the same place.[2] Their matrix can scarcely be called sandy, but is a calcareous stone of a bluish-green colour with lighter oolitic grains, and is similar to that in which *Lioc. opalinum* occurs at Burton Bradstock. Mr. Sharpe's two sections will explain its position with regard to the Upper Lias Clay, and to the beds above.

From the Bed B of Mr. Walford's section,[3] Otley Hill, near Hook Norton, Oxfordshire, I have through his kindness seen specimens of *Lioceras*

[1] At Yeovil, Bradford Abbas, &c., there seems to be no trace of the *Opalinum*-beds, and, therefore, the whole of the sands there may be below that horizon.

[2] This locality is sometimes called "New Duston" on account of some *new houses* that have sprung up round the *old workings*.

[3] "On the Trigoniæ of North Oxfordshire," 'Quart. Journ. Geol. Soc.,' vol. xli, 1885, p. 38.

opalinum. This bed is called by him a "sandy blue-hearted limestone." Both Mr. Walford and Mr. Sharpe quote *Am. Murchisonæ* from the same bed as *Am. opalinus*, but Mr. Walford informs me that he somewhat doubts this identification, as well as that of *Am. læviusculus* which he gives, and I expect that the same must be said of Mr. Sharpe's. The *Lioceras opalinum* at Hook Norton was associated with a species of *Hammatoceras* (?), which Mr. Thompson also sent me from New Duston, and which also occurs with *Lioc. opalinum* at Burton Bradstock, so that probably there can be little doubt of the identity of this horizon (the *Opalinum*-zone) throughout these Counties.

I have thus gone somewhat fully into the position of *Lioceras opalinum*, first because palæontological details are very insufficient unless accompanied, wherever possible, with the full geological conclusions to which they lead us, especially in the case of *Ammonites*, which have been used to designate the zones; secondly, the zone of *Lioceras opalinum* is more persistent and more recognisable than perhaps any other in the Inferior Oolite; and, thirdly, because, lying as it does at or near the base of the Inferior Oolite, it is a most useful geological landmark that ought to be fully established. I have verified its occurrence in the Counties of Dorset, Gloucester, Oxford, and Northampton by an examination of specimens of the characteristic *Ammonites*.

Lioceras opalinum, *var.* comptum (*Reinecke*). Pl. XIII, fig. 11; Pl. XIV, figs. 3, 4, 5, 6. (Pl. XIII, fig. 12; Pl. XIV, figs. 1, 2, 7, 8, 9 doubtful forms).

1818. Nautilus comptus, *Reinecke*. Maris Protog., figs. 5, 6.
1884. Harpoceras opalinum, *Wright*. Lias Ammonites, Pal. Soc., pl. 80, fig. 4.
1885. — comptum, *Haug*. Beiträge Monog. Harpoceras, Neues Jahrbuch, Beil.-Bd. iii, p. 681.
1886. — opalinum, *Vacek*. Oolithe Cap San Vigilio, Abh. der k. k. geol. Reichsanstalt, Wien, Bd. xii, No. 3, pl. vi, figs. 6, 7, 13, only.
1886. — ? Murchisonæ, *Vacek* (non *Sowerby*). Ibid., Pl. vii, fig. 5.

It is rather difficult from a mere examination of Reinecke's figure of *Nautilus comptus* to say what it may be, and the identification should be regarded only as the most probable until reference can be made to the original specimen if it exists. That there is very great similarity between the little specimen, Pl. XIII, fig. 11, and Reinecke's original figure, cannot, I think, be denied. Dr. Haug considers that what Dr. Wright figured as *Lioc. opalinum* with fascicled ribs (loc. cit.) is the adult form; but Dr. Wright placed *Nautilus comptus* as a synonym of

his *Harpoceras aalense* with a query. Dr. Vacek, page 72, states that he considers that a number of specimens of *Harp. opalinum* from Cap San Vigilio belong to Haug's *Harp. opalinum*, var. *comptum*, especially pl. vi, figs. 15 and 16. Having some doubt, however, with respect to these figures, I have not included them in my synonymy; and in fact I am somewhat doubtful if they should be included in *Lioceras* at all. Vacek's figures 6, 7, and 13 on pl. vi I recognise as the varietal form *comptum*, and I am inclined to think that fig. 5, pl. vii, is very closely allied.

From *Lioceras opalinum* this variety differs chiefly in the form of ribbing. The striæ are not actually fascicled, but the inner portion of the sides of the whorl are periodically bulged in the direction of the striæ, and these striæ pass continuously over these bulgings which have, when the test is absent, all the appearance of regular ribs, and give to the umbilicus the appearance of being ribbed. The umbilicus is also larger than in *Lioc. opalinum*, and the walls are much straighter. The sides of the whorls are more parallel and not so depressed on the inner area. When the test is absent this variety has a slight resemblance in its ribbing to *Ludwigia Murchisonæ*, but the number of fine striæ in connection with a rib or bulge on the inner area shows the difference. This form also somewhat resembles *Gramm. aalense* (Zieten), but the fine striæ again distinguish it from the coarse, irregularly-joined ribs of that species; the possession too of a concave inner margin is a distinction, not to mention the difference of the sutures.

I have little doubt that this variety was partly concerned with Dr. Lycett's ideas about the various *Ammonites opalinus*, *aalensis*, *comptus*, &c. He found a most complex state of things, namely, *Lioc. opalinum* with very fine striæ, *Gramm. Moorei* the same, and with traces of coarser ribs in the centre, *Lioc. comptum* with (when the test is absent) coarse ribs on the inner area and centre, and *Gramm. aalense* with coarse ribs; and, perhaps noticing the similarity between *Lioc. opalinum* and *comptum*, he united them but could find no strong reason for separating *Gramm. Moorei* from *Gramm. aalense*, or from *Lioc. opalinum*. By pointing out, later on, the descent or evolution of these various *Ammonite*-forms, I hope to be able to show that, in spite of a rather deceptive outward appearance, these *Ammonites* are really somewhat widely separated, and that those ideas partly arose because the real importance of certain characteristics was not fully appreciated.

I have not so much material belonging to this variety as I could wish. A more extended series would show better both the connection and distinction between the forms with these waves or false ribs and the true *Lioc. opalinum*. We have, however, first what I imagine to be Reinecke's *comptus*, Pl. XIII, fig. 11, somewhat

larger, Pl. XIV, figs. 3 and 4, and an adult figured by Dr. Wright, 'Lias Am.,' pl. lxxx, fig. 4; secondly, a form showing slightly a wider umbilicus, and seeming to commence with coarser ribs, but as the test is not well preserved little can be said on this point (Pl. xiv, figs. 5, 6); thirdly, forms which seem to be connected with *Lioc. opalinum* and which in general proportions of umbilicus, &c., agree exactly with that species, but have some tendency to show these waves or false ribs. Pl. XIV (fig. 1 *only*) gives a side view which may pass for such a form, and which represents those of which I am speaking except that they are thinner. Pl. XIII, fig. 12, shows a portion of one of them with the commencement of the lateral process of the mouth-border. Then lastly d'Orbigny has figured a thicker form ('Pal. franç. Ceph.,' pl. lxii, figs. 1 and 2) under the name *Am. primordialis*, not yet obtained by me. The specimen figured Pl. XIV, figs. 1 and 2, resembles it in thickness, but has a much smaller umbilicus. This may possibly be the young of a peculiar form, of which I have given a figure in the hope that more may be procured (Pl. XIV, figs. 7, 8, and 9). This form commences with fine striæ, and slight indications of waves, which afterwards change to somewhat coarse ribs. It is certainly considerably different from either *Lioc. opalinum* or *comptum*.

Lioc. comptum is not a common form. It occurs in the same bed with *Lioc. opalinum*. I possess specimens from Haresfield Hill and North Nibley in Gloucestershire. From Somerset I have one specimen, not well preserved, labelled "Haselbury." In Dorset I have obtained a few small specimens at Burton Bradstock.[1] The kindness of Mr. B. Thompson, F.G.S., has enabled me to examine two very good specimens of this variety from New Duston in Northamptonshire collected by himself and Mr. W. D. Crick from what is there known as the Northampton Sand. Unfortunately these arrived too late to be included in the plates. The intermediate forms I have obtained from Burton Bradstock, Dorset, and from Stinchcombe Hill, Gloucestershire.

Pl. XIII, fig. 11, shows a young specimen of Reinecke's form. This will serve for comparison with his figure and also with the specimen, fig. 6, of a young *Lioc. opalinum*. On account of the absence of the test its ribs appear much coarser than they otherwise would. Pl. XIV, figs. 3, 4, represent an older specimen of the same form, with a large portion of the test well preserved. Both these specimens are from Burton Bradstock. Pl. XIV, figs. 5, 6, represent another form not well preserved, but useful for comparison with the other two placed by the side of it. This is from Haresfield Hill, Gloucestershire. Pl. XIII, fig. 12, shows a portion of one of the forms intermediate between *Lioc. comptum* and *opalinum*, showing the commencement of the termination. Pl. XIV, figs. 1, 2, indicate a thick form with small umbilicus and rather sharp carina. The test is

[1] At this place I have also obtained some specimens which seem to agree with Vacek's, pl. vi, figs. 15 and 16, but which I think do not belong here. The material, however, is as yet insufficient.

very well preserved. Both these specimens are from Burton Bradstock. Pl. XIV, fig. 7, gives the side view of a specimen which is difficult to place with either *Lioc. opalinum* or *comptum* without further evidence. It shows a very distinct change in the nature of its ribbing. It came from the same bed at Haresfield Hill in which *Lioc. opalinum* occurs plentifully. Its test is fairly well preserved. Fig. 8 shows its thickness and fairly sharp carina; fig. 9 shows the carina and ventral area a little farther back than the top of fig. 8, which is broken off.

Lioceras concavum (*Sowerby*). Plate II, figs. 6, 7; Plate VIII, figs. 1—4.

1815. Ammonites concavus, *Sowerby*. Min. Conch., vol. i, pl. 94, lower figure p. 214.
1881. Harpoceras concavum, *S. Buck*. Ammon. Inf. Ool. Dorset, Quart. Journ. Geol. Soc., vol. xxxvii, p. 603.
1885. — — *Haug*. Beitr. Monog. Harpoceras, Neues Jahrbuch, Beil.-Bd. iii, pl. 12, figs. 12 *a*, *b* (a variety).

(Non *Ammonites concavus*, d'Orbigny, Dumortier, &c.)

Discoidal, compressed, sub-carinate. Whorls sub-convex, but with the inner margin slightly raised, causing the inner area to be slightly depressed and sub-concave, ornamented with sigmoidal radii, which, beginning as mere lines of growth, and so continuing across the inner area, become rather broad, but not prominent ribs on the outer area. The ribs then die away rather quickly at the edge of the ventral area, and, continuing as striæ, can be traced across the carina, upon which they unite at an acute angle. Ventral area acutely sloped, with the carina, though prominent, not really distinct, but as if formed by the compression of the sides of the ventral area. Inner margin concave, and inclined at about an angle of 60°. Inclusion almost to the upper edge of the inner margin of the previous whorl, forming a small, almost regularly concave, umbilicus. The termination of the body-chamber is sigmoidal,[1] generally quite plain when the test is present, but, with one or more constrictions, visible on the mould, caused by a thickening of the test; the length of the body-chamber is exactly half a whorl.[2]

I have here purposely confined myself to a description of the typical form of this species, which I have been able to identify by an actual comparison of Sowerby's type-specimen with my own, and this type-specimen of Sowerby's I

[1] No elongated lateral processes are visible at a diameter of three inches, but they probably occur at an earlier age.

[2] These characters of the body-chamber are shown by a specimen which I have not thought it necessary to figure.

PLATE VII.[1]

Murchisonæ-zone.

Figs. 1—6.—Lioceras ambiguum, *S. Buckman.*

Fig. 1.—Side view of a fine, well-preserved specimen, showing the small striæ and indications of ribs, as well as the sudden recession of the inner margin. Bradford Abbas, Dorset. Collected by my father. (Page 26.)

Fig. 2.—The same specimen, showing the front view.

Fig. 3.—A portion of another specimen to show the side view of the termination. Bradford Abbas, Dorset. My Collection. (Page 27.)

Fig. 4.—View (from above) of the termination of this specimen, showing the rounded ventral process. [A very slight carina should have been indicated along the middle.]

Fig. 5.—Side view of a young specimen, possessing nearly the whole of the body-chamber, and thus showing a large umbilicus. Bradford Abbas, Dorset. My Collection. (Page 27.)

Fig. 6.—Front view of the same specimen.

Lioceras ambiguum, *var.* costatum, *S. Buckman.*

Fig. 7.—Side view of a fine specimen, with all its test preserved and part of the termination of the body-chamber visible, showing numerous peculiar ribs which characterise this variety, and a smaller umbilicus. Haselbury, Somerset. My Collection. (Page 29.)

[1] In Plates VII and onwards all the specimens are figured of the natural size unless otherwise stated.

PLATE VII.

Fig. 1.

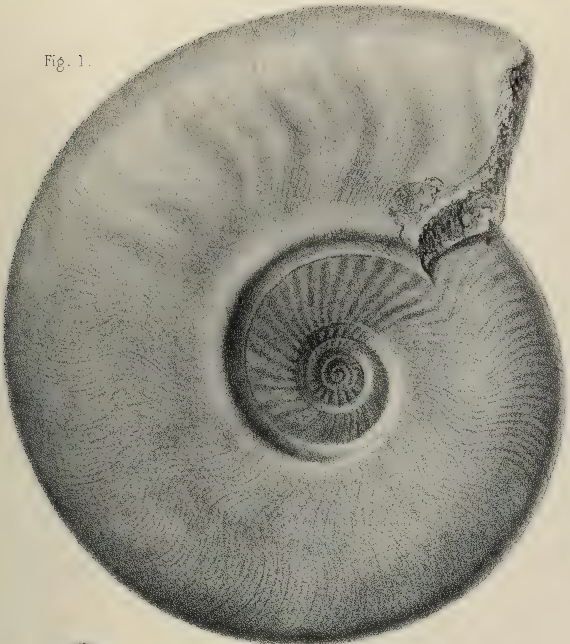


Fig. 3.

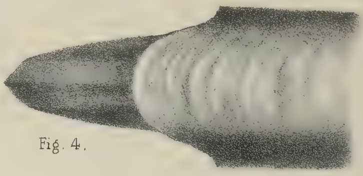


Fig. 4.

Fig. 2.

Fig. 6.

Fig. 7.

Fig. 5

Gawan del et lith.

Mintern Bros. imp.

PLATE VIII.

Sowerbyi-zone (Concavum-beds).

LIOCERAS CONCAVUM (*Sowerby*).

Fig. 1.—Side view of a typical adult specimen with greater portion of the test well preserved. The cross shows the last suture-line. Bradford Abbas, Dorset. Collected by my father. (Page 56.)

Fig. 2.—Front view of the same, showing acutely sloped ventral area.

Fig. 3.—A finer ribbed specimen, at an earlier age. Side view. Entire test most perfect. Bradford Abbas, Dorset. My Collection.

Fig. 4.—Front view of the same.

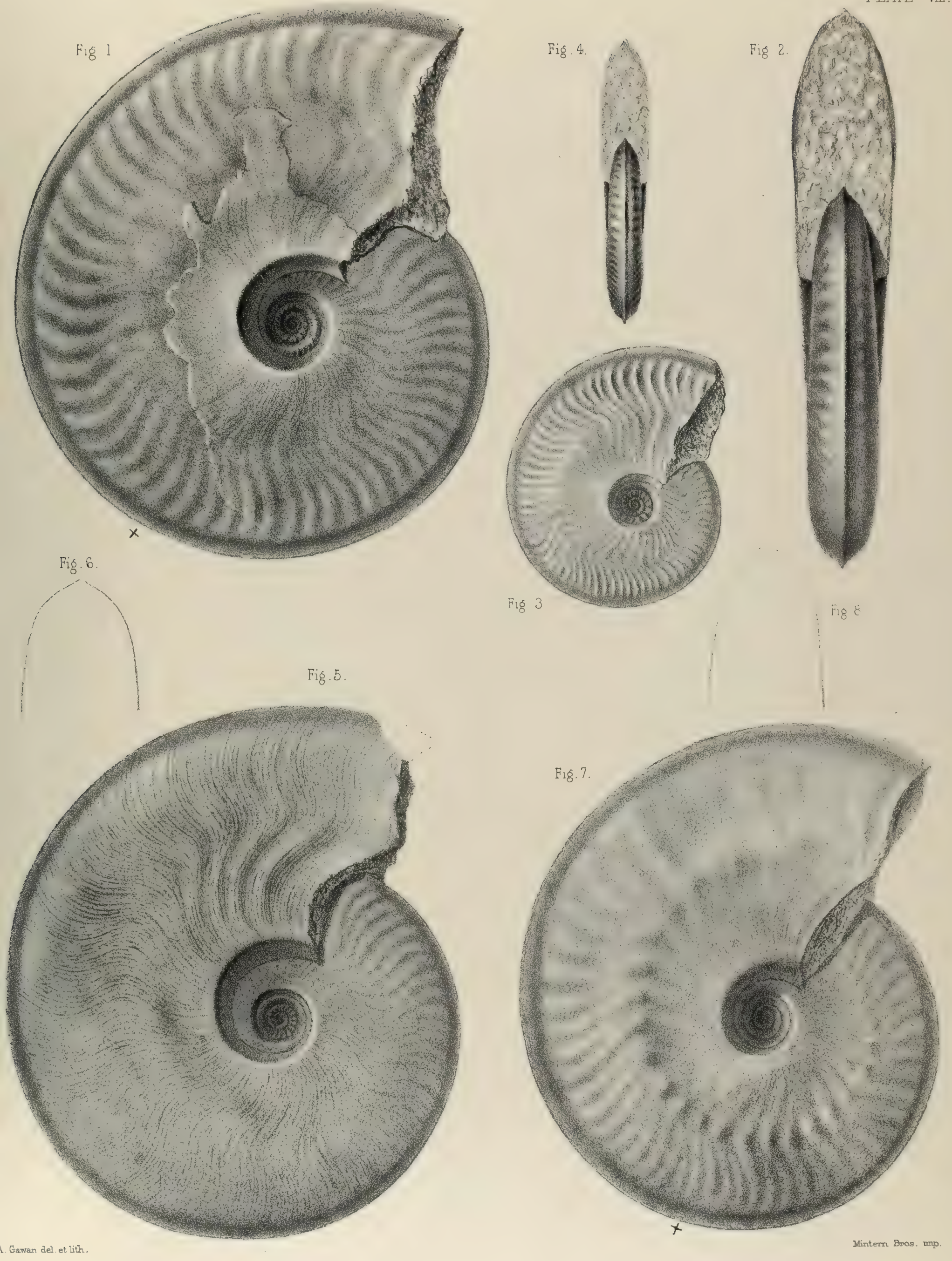
Fig. 5.—A very peculiar variety, with extremely fine striæ, and small deep umbilicus. All the test present, and the mouth-border. Bradford Abbas, Dorset. My Collection.

Fig. 6.—Outline of the ventral area, and the body-chamber of the same specimen, to show small amount of carina.

Fig. 7.—Another peculiar variety, with indications of small knobs on the lateral area. All the test preserved. Very straight mouth-border. Bradford Abbas, Dorset. My Collection.

Fig. 8.—Outline of the ventral area of the body-chamber of the same specimen, showing that it is more acute, and has more carina than in Fig. 6.

PLATE VIII.



A. Gawan del. et lith.

Mintern Bros. imp.

PLATE IX.

Sowerbyi-zone (Concavum-beds).

Figs. 1—7.—Lioceras concavum, *var.* v-scriptum, *S. Buckman.*

Fig. 1.—A fine adult form, showing small hollow umbilicus, and complete mouth-border. The test is well preserved. Bradford Abbas, Dorset. Collected by my father.

Fig. 2.—Front view of the same specimen.

Fig. 3.—View of the other side of the same specimen, where the test is absent, showing the ridges and furrows produced by the varying thickness of the test. This view of the same specimen was figured by my father in the 'Quart. Journal of the Geological Society,' 1881.

Fig. 4.—Suture-lines of the specimen *in situ*, showing part of siphonal, and superior and inferior lateral lobes, and siphonal and superior lateral saddles with the accessory lobes in them, and also the manner in which the previous lobes are penetrated by those succeeding. The cross shows the position of the last suture-line, indicating a body-chamber of exactly half a whorl.

Fig. 5.—A front view of a young specimen. The carina is, if anything, rather too distinct.

Fig. 6.—Side view of the same specimen with nearly all the test preserved. This is a young immature form, with a somewhat smaller umbilicus, and is in reality the young of the specimen figured in Plate VI. (The carina seems a little too prominent.) Bradford Abbas, Dorset. Collected by my father.

Fig. 7.—Side view of a small shell, showing the small pointed lateral process, also the less inclusion of the whorls in youth. The greater portion of the test is preserved. Bradford Abbas, Dorset. My Collection.

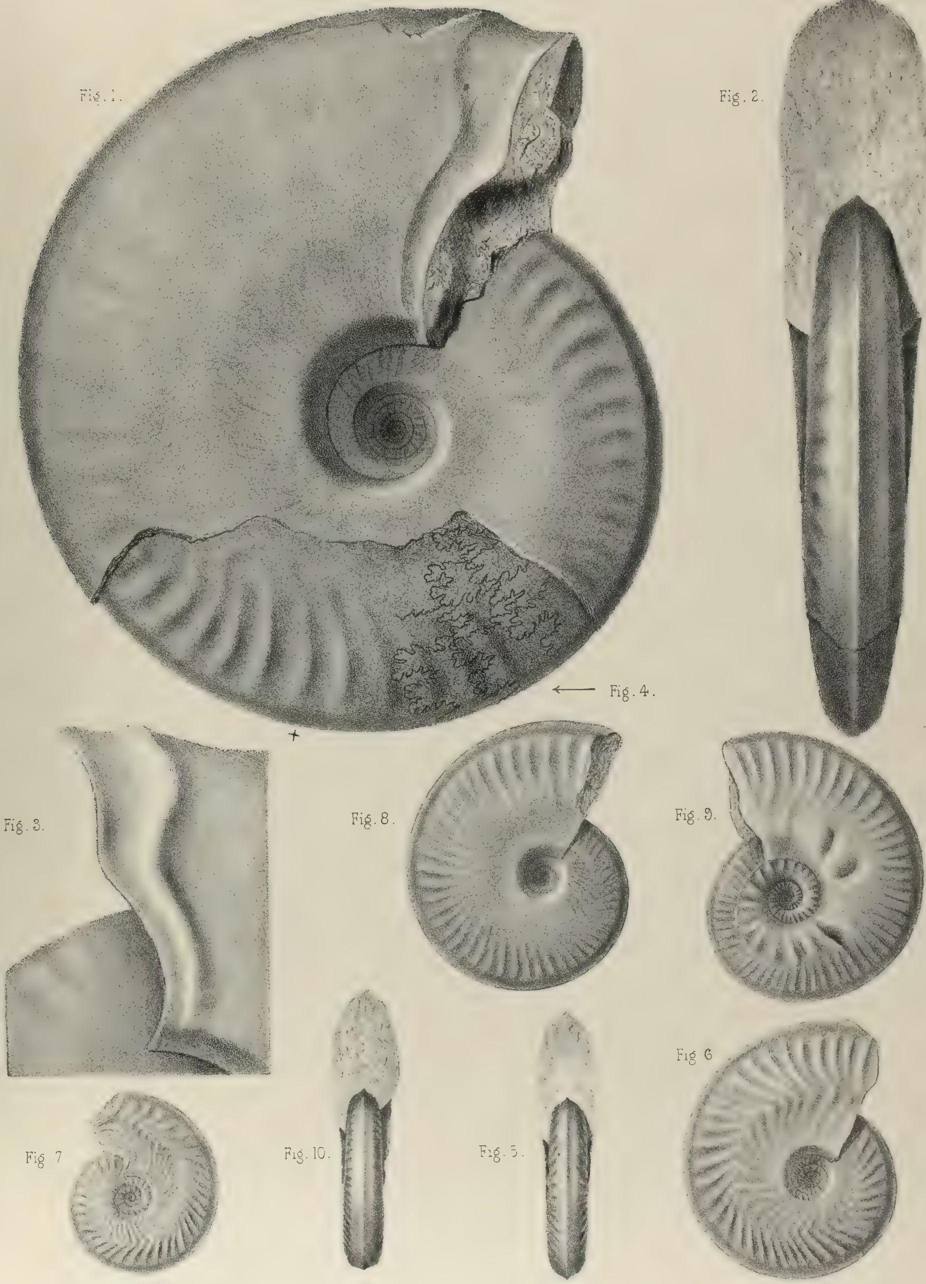
Figs. 8—10.—Lioceras concavum (*Sowerby*); abnormal form.

Fig. 8.—Side view showing regular whorls and umbilicus. Bradford Abbas, Dorset. Collected by my father.

Fig. 9.—View of the other side of the same specimen, showing abnormally formed whorls and umbilicus, and with indentations on the inner area of whorl.

Fig. 10.—Front view of the same specimen, showing one side with regular concave inner margin, the other shorter and without any. The test is entirely preserved in this specimen.

PLATE IX.



A. Gawan del et lith. Mintern Bros. imp.

PLATE X.

Sowerbyi-zone (Concavum-beds).

Figs. 1, 2.—LIOCERAS CONCAVUM, *var.* FORMOSUM, *S. Buckman.*

Fig. 1.—Side view of a very fine adult specimen, with extremely well-preserved test and beautifully complete mouth-border. (The ribs are shown somewhat too conspicuous.) Bradford Abbas, Dorset. Collected and lent for figuring by the late Mr. E. Witchell, F.G.S.; and kindly presented to me by Mrs. Witchell.

Fig. 2.—Front view of the same specimen, showing acute ventral area and compression of the inner area.

Figs. 3, 4.—LIOCERAS CONCAVUM (*Sowerby*) variety.

Fig. 3.—Side view of a specimen with small hollow umbilicus, showing the mouth-border. The test on the specimen is well preserved, especially on the ventral area. Bradford Abbas, Dorset. My collection.

Fig. 4.—Back view of the same specimen showing ventral area and carina.

Figs. 5—8.—LIOCERAS CONCAVUM, *var.* V-SCRIPTUM, *S. Buckman.*

Fig. 5.—The thick form of this variety. Side view, showing the change from V-shaped to sigmoidal ribs. Probably from Bradford Abbas, Dorset. Collected by my father.

Fig. 6.—Front view of the same specimen, showing its thicker proportions and practically absent carina. Where the whorls enter the aperture the carina is shown too acute.

Fig. 7.—A young form of the specimen figured Plate IX, fig. 1. Side view, showing V-shaped ribs. To compare with fig. 10. Bradford Abbas, Dorset. My collection.

Fig. 8.—Front view of the same specimen.

Fig. 9.—LIOCERAS CONCAVUM (*Sowerby*) variety.

Fig. 9.—A portion of the side view of a peculiar form, intermediate between this and *Lioceras v-scriptum*, showing strongly-marked ribs on the middle of the lateral area. Bradford Abbas, Dorset. Collected by my father.

Figs. 10, 11.—LIOCERAS APERTUM, *S. Buckman.*

Fig. 10.—Side view of the type specimen, showing the open umbilicus. Bradford Abbas, Dorset. Collected and lent for figuring by the late Mr. E. Witchell F.G.S.; and kindly presented to me by Mrs. Witchell.

Fig. 11.—Front view of the same, showing compressed parallel sides and almost absent carina.

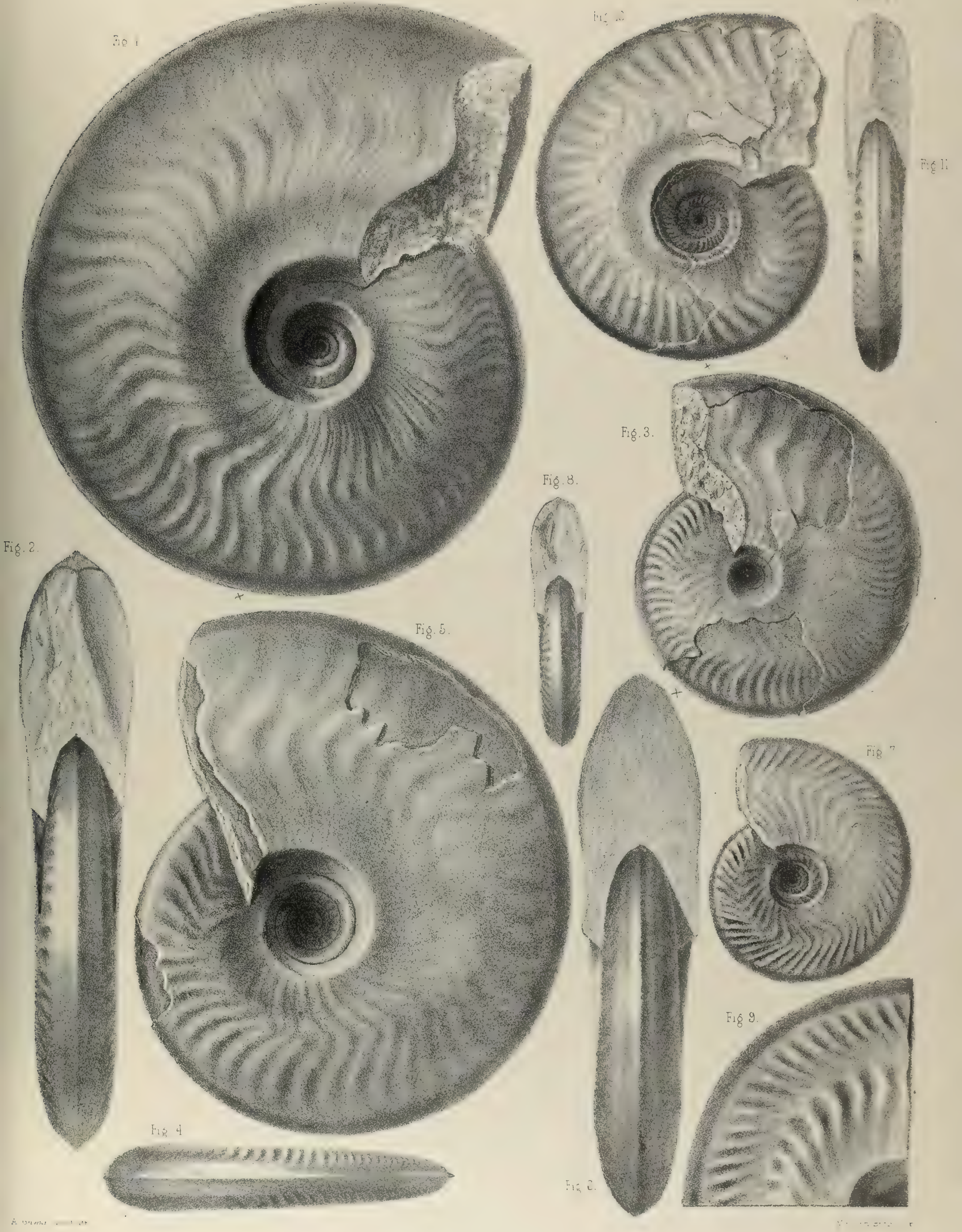


Fig. 2.
Fig. 3.
Fig. 4
Fig. 5.
Fig. 8.
Fig. 9.
Fig. 11

PLATE XI.

Murchisonæ-zone.

Fig. 1.—LIOCERAS BRADFORDENSE, *var.* GIGANTEUM, *S. Buckman.*

Fig. 1.—Side view of a large adult specimen, showing the small deep umbilicus and the smooth test when adult. The cross shows the position of the last suture-line. From Beaminster, Dorset. My Collection. (Page 25.)

Sowerbyi-zone (Concavum-beds).

Figs. 2—7.—LIOCERAS DECIPIENS, *var.* INTERMEDIUM, *S. Buckman.*

Fig. 2.—Side view of a specimen with the whole test very well preserved. Bradford Abbas. Collected by my father. (Page 33.)

Fig. 3.—Front view of the same. No part of the body-chamber is present.

Fig. 4.—Side view of the more compressed sub-variety A, showing absence of ribs in the umbilicus. The test is extremely well preserved. Bradford Abbas. My Collection. (Page 33.)

Fig. 5.—Front view of the same specimen.

Fig. 6.—Side view of the sub-variety B, showing more marked ribs on outer area and larger umbilicus than that in Fig. 2. Bradford Abbas. My Collection. (Page 33.)

Fig. 7.—Front view of the same specimen.

PLATE XI

Fig 6.

Fig 4.

Fig 5

Fig 7

Fig 2

Fig. 1.

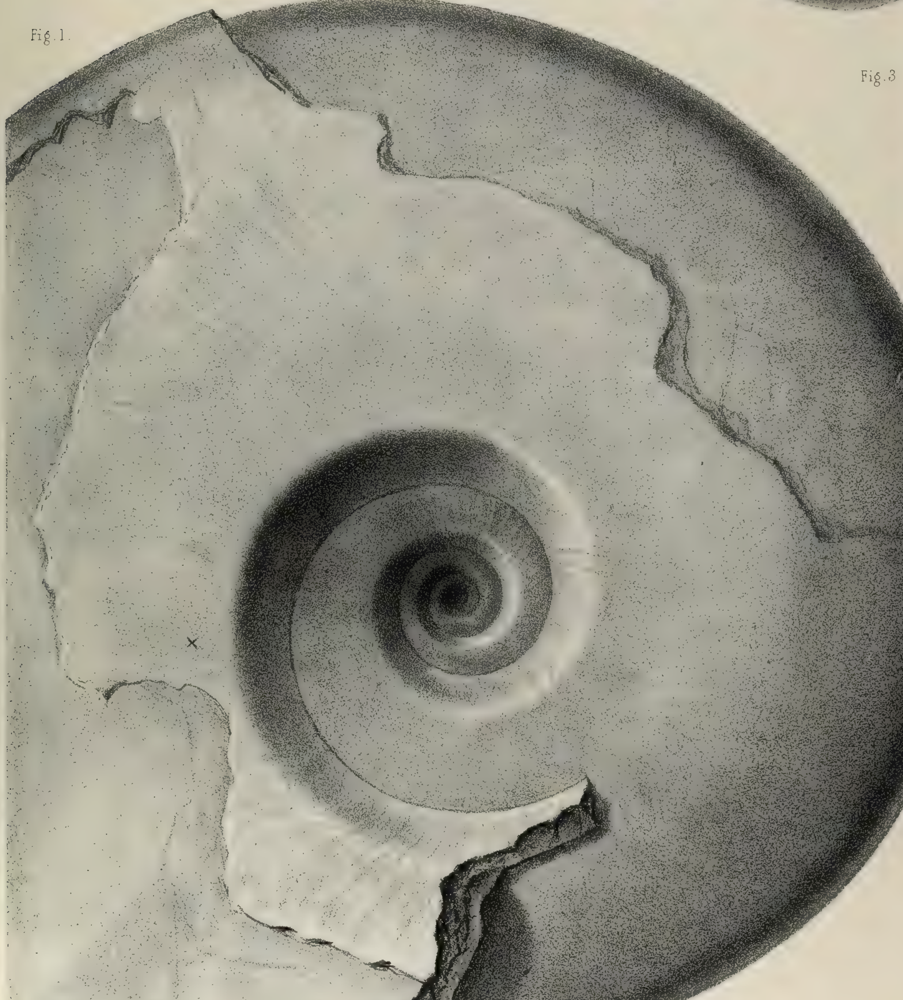


Fig. 3

A Gawan del et lith

Mintern Bros imp

PLATE XII.

Sowerbyi-zone (Concavum-beds).

Figs. 1—3.—Lioceras concavum, *var.* pingue, *S. Buckman.*

Fig. 1.—Side view of a specimen with part of the termination to the body-chamber. The test is well preserved. Halfway House, near Sherborne, Dorset. My Collection.

Fig. 2.—Front view of the same specimen.

Fig. 3.—A sectional view of the hollow umbilicus of the same specimen (to compare with Fig. 7).

Murchisonæ-zone.

Figs. 4—7.—Lioceras bradfordense, *var.* giganteum, *S. Buckman.*

Fig. 4.—Front view of the specimen drawn on Plate XI, fig. 1. The test covers the whole of the ventral area shown, and is also seen at the top of the figure. Natural size. (Page 25.)

Fig. 5.—Side view of a young specimen with all its test well preserved. Stoke Knap, near Broad Windsor, Dorset. My Collection. (Page 25.)

Fig. 6.—Front view of the same specimen.

Fig. 7.—Sectional view of the umbilicus of the same specimen, showing the edges of the inner whorls (to compare with Fig. 3).

Sowerbyi-zone (Concavum-beds).

Figs. 8, 9.—Lioceras decipiens, *S. Buckman.*

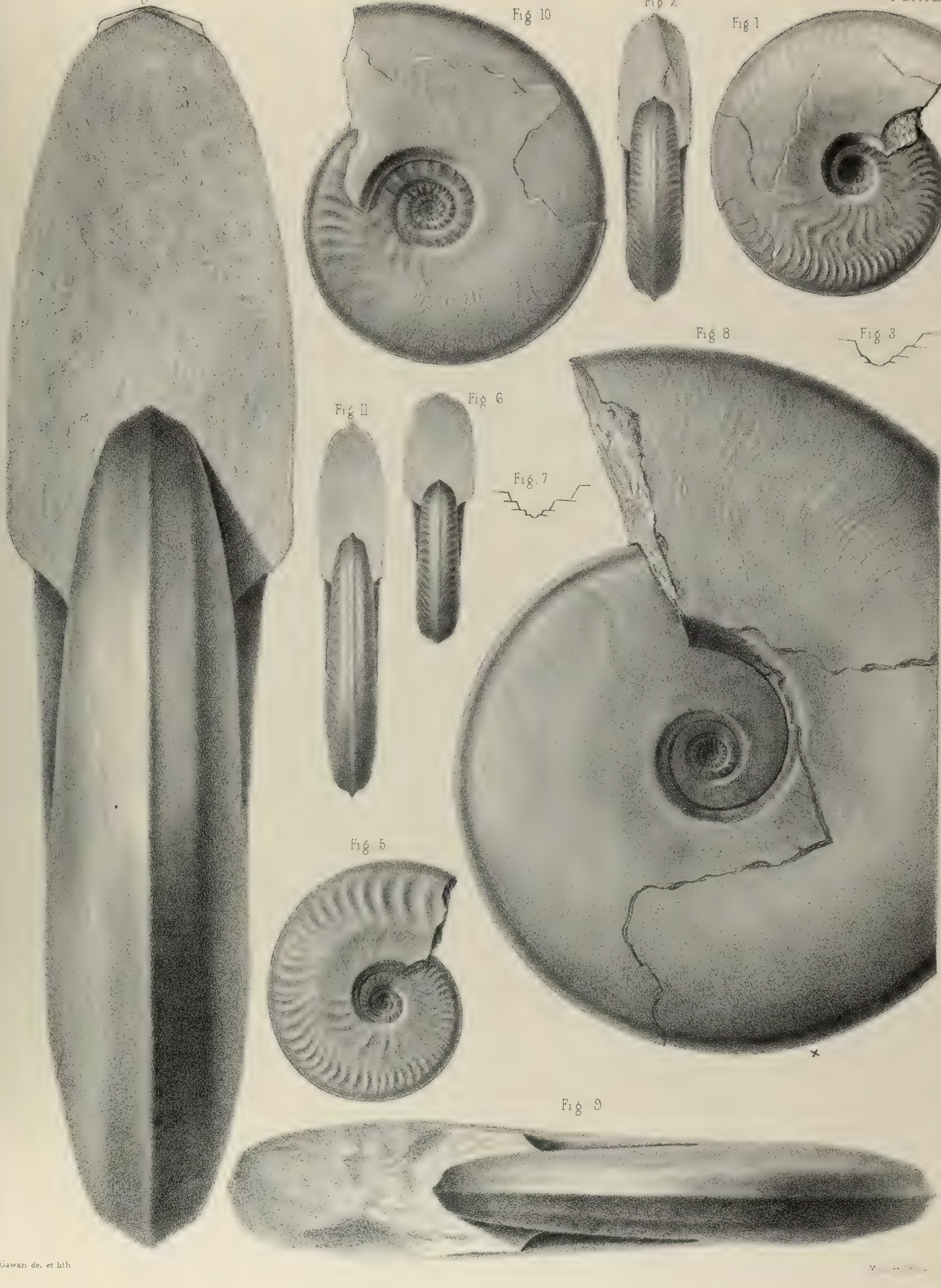
Fig. 8.—Side view of a large specimen showing very smooth test, which is well preserved, and part of the termination of the body-chamber. (The shell on the body-chamber has been drawn from what exists on the other side.) The cross shows the situation of the last suture-line. From near Sherborne, Dorset. Collected by my father. (Page 30.)

Fig. 9.—Front view of the same specimen, showing flat ventral area and small but distinct carina.

Lioceras decipiens, *var.* intermedium?

Fig. 10.—Side view of a doubtful form, with more prominent inner costæ (to compare with *Lioceras decipiens*, *Lioc. intermedium*, and *Hyperlioceras Walkeri*). (Page 34.)

PLATE XII.



A Gawan del. et lith

PLATE XIII.

Opalinum-zone.

Figs. 1—10.—Lioceras opalinum (*Reinecke*).

Fig. 1.—Side view of a typical large specimen, with almost the whole of the body-chamber present, and with the test extremely well preserved. Haresfield Hill, Gloucestershire. My Collection. (Page 35.)

Fig. 2.—Front view of the same specimen, showing the almost complete absence of a carina, and also the rounded ventral area of the body-chamber.

Fig. 3.—Side view of a portion of a large specimen, five and a half inches in diameter, to show the termination to the body-chamber. Haresfield Hill. My Collection. (Page 36.)

Fig. 4.—Side view of a small typical specimen (to compare with Reinecke's figure). Coaley Wood, Gloucestershire. My collection. (Page 36.)

Fig. 5.—Front view of the same specimen, showing that the carina is slightly more developed in youth.

Fig. 6.—Side view of a very small specimen. Burton Bradstock, Dorset. My Collection. (Page 36.)

Fig. 7. Side view of a somewhat compressed variety with wider umbilicus and more sloping inner margin. Only a portion of the body-chamber is present, as shown by the ×. Haresfield Hill. My Collection. (Page 39.)

Fig. 8.—Front view of the same specimen. The upper portion of the last whorl has the test off, and shows a peculiarly compressed section.

Fig. 9.—Side view of a younger specimen of the more widely centred variety. Haresfield Hill. My Collection. (Page 39.)

Fig. 10.—Front view of the same.

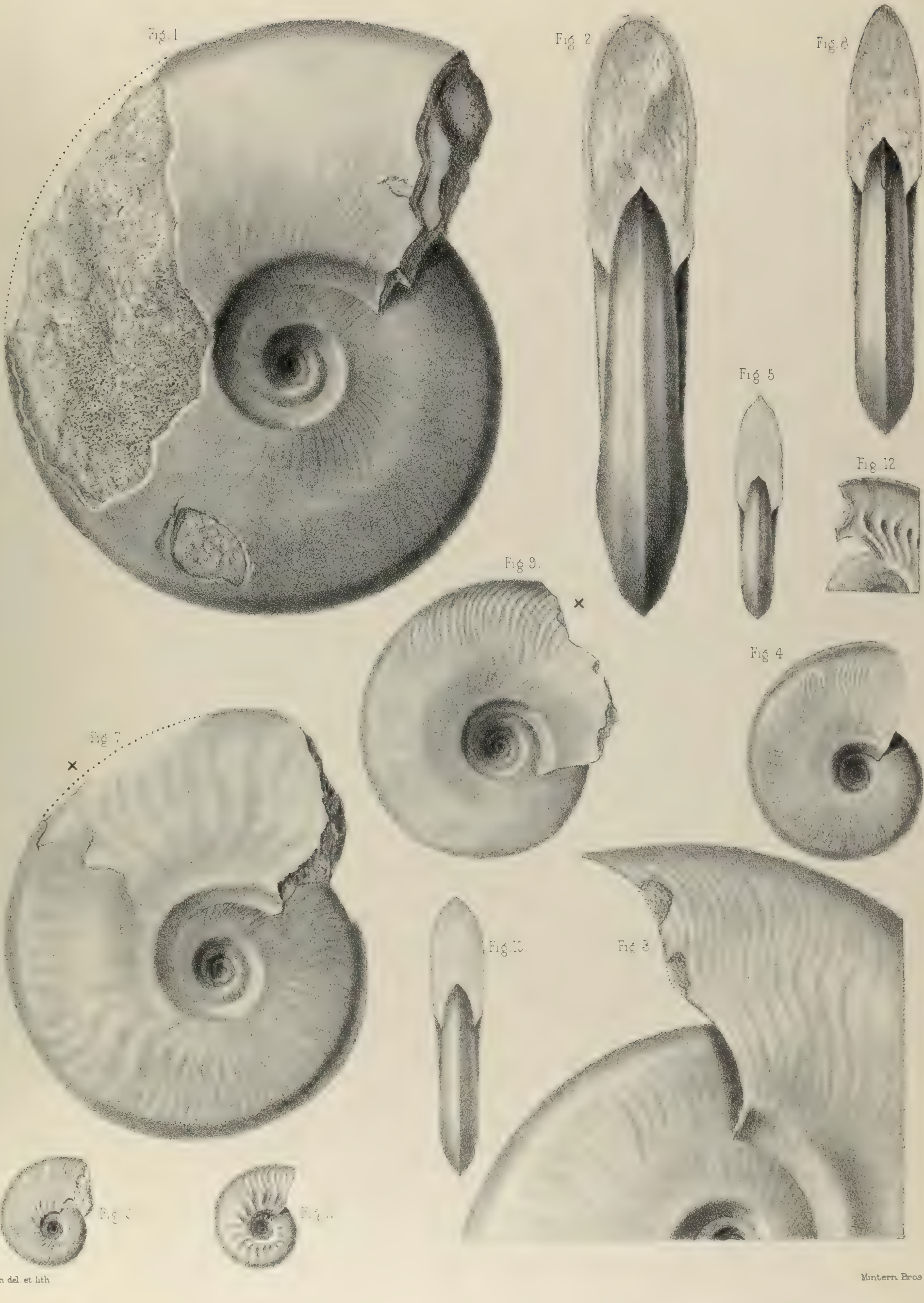
Lioceras opalinum, *var.* comptum (*Reinecke*).

Fig. 11.—Side view of a very young specimen (to compare with Reinecke's figure, and also with fig. 6). The test is absent and the striæ are consequently more prominent. Burton Bradstock. My Collection. (Page 55.)

Intermediate form.

Fig. 12.—Portion of a variety between *Lioc. opalinum* and *comptum*, showing the commencement of the lateral process to the termination, which the young shells possess. Burton Bradstock. My Collection. (Page 54.)

PLATE XIII.



A. Gawan del. et lith

Mintern Bros. imp.

PLATE XIV.

Opalinum-zone.

Figs. 1—6 (1 and 2 ?).—Lioceras opalinum, *var.* comptum (*Reinecke*).

Fig. 1.—Side view of a thick, small-centred specimen with some characters of both *Lioc. opalinum* and *comptum,* but differing from either of them. Burton Bradstock. My Collection. (Page 55).

Fig. 2.—Front view, showing its thickness and prominent carina.

Fig. 3.—Side view of a true form with part of test extremely well preserved. Burton Bradstock. My Collection. (Page 55.)

Fig. 4.—Front view of the same specimen.

Fig. 5.—Side view of a more widely centred variety. Haresfield Hill. My Collection. (Page 54.)

Fig. 6.—Front view of the same specimen.

Figs. 7—9.—Lioceras, sp. ?

Fig. 7.—Side view of a specimen with well-preserved test, showing a change from striæ to coarser ribs. Haresfield Beacon. My Collection. (Page 53.)

Fig. 8.—Front view of the same specimen, the inner margin is drawn somewhat too much sloped.

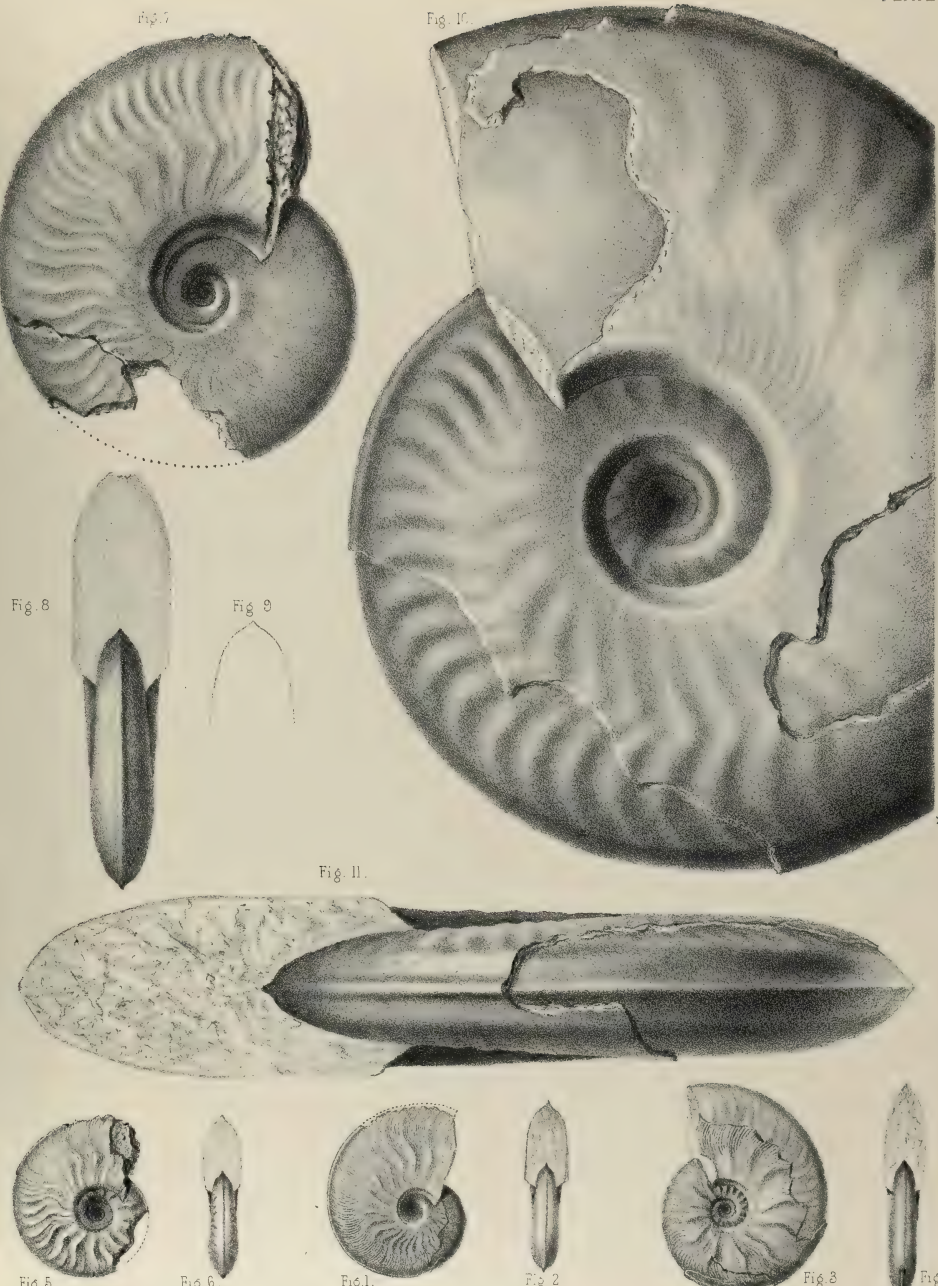
Fig. 9.—(To supplement fig. 8, which is broken.) Taken from a little further back to show the ventral area and carina accurately in section.

Sowerbyi-zone (Concavum-beds).

Figs. 10, 11.—Lioceras fallax, *S. Buckman.*

Fig. 10.—Side view of a large specimen, with greater portion of the test present, showing the umbilicus, with portions of the inner whorls exposed. Bradford Abbas, Dorset. Collected by my father.

Fig. 11.—Front view of the same specimen, showing the ventral area and carina, both with and without test.



A. Gawan del. et lith.

Mintern Bros. imp.